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JOURNAL

OF THE

UNITED STATES ARTILLERY



PUBLISHED UNDER SUPERVISION OF THE SCHOOL BOARD
OF THE COAST ARTILLERY SCHOOL

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JOURNAL
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UNITED STATES ARTILLERY

*"La guerre est un métier pour les ignorans
et une Science pour les habiles gens."*

VOL. 33 No. 1 JANUARY—FEBRUARY, 1910 WHOLE No. 101

PROCEEDINGS OF THE COAST ARTILLERY BOARD

Fort Monroe, Virginia, December 11, 1909.

Subject:—Competitive test of azimuth instruments. 1392/1
C.A.B. 5673/8 O.C.C.A

ACTION

The Board met at 10 o'clock A.M., November 1, 1909.

Present:

Major Richmond P. Davis, Coast Artillery Corps.

Captain Harrison Hall, Coast Artillery Corps.

Captain William F. Hase, Coast Artillery Corps.

Captain Jesse C. Nicholls, Coast Artillery Corps.

Captain Claudius M. Seaman, Coast Artillery Corps.

The following azimuth instruments were submitted for test:

Warner and Swasey Company, Cleveland, Ohio, Mr. George Fecker, representative.

Bausch & Lomb Optical Company, Rochester, New York, Mr. J. L. Saegmuller, representative.

Frankford Arsenal, Captain G. F. Jenks, Ordnance Department, representative.

The credentials of the representative of the instruments submitted for test were received and the specifications and program of the tests, Appendices A and B, were considered. Before final adjournment the representatives were assembled and informed that the Board had sufficient data to enable it to reach a conclusion; each representative was asked in turn if he desired a continuance of the test or wished to suggest any further test; each

expressed himself satisfied. Each representative was directed to submit a letter in compliance with paragraph 13 of the program of test; these letters were submitted and are hereunto appended, marked C-C'-C"; D-D'-D".*

The instruments were located in the Battery Commander's station of Battery Eustis, the Warner and Swasey being on the pier mount for the azimuth instrument of the station, the other instruments being on tripods 3.9 feet to the right and left. Photographs of the instruments are shown herewith.

The Board met daily until November 4, at which time the program was completed; the first day was devoted to a general inspection of the instruments; the representatives described their instruments, which were examined in turn by the members of the Board, and such descriptions as were given by letter are hereunto appended and marked E & E',† W. & S.; E", B. & L.; E"', F.A.; on the second and third days accuracy tests were conducted; on the fourth day the instruments were inspected carefully, the emergent pencils measured, powers calculated and tests made for definition.

The record of the accuracy tests is shown by the tables below:

Table I

Average error, officers and enlisted men observing.

W. S.	0°.0112
B. L.	0°.0169
F. A.	0°.0188

Observations after 45 minutes continuous turning *not* included.

In accordance with this table, the following is the order of accuracy:

1. Warner & Swasey.
2. Bausch & Lomb Optical Company.
3. Frankford Arsenal.

Table II

Average error, representatives observing.

W. S.	0°.0084
F. A.	0°.0084
B. L.	0°.0124

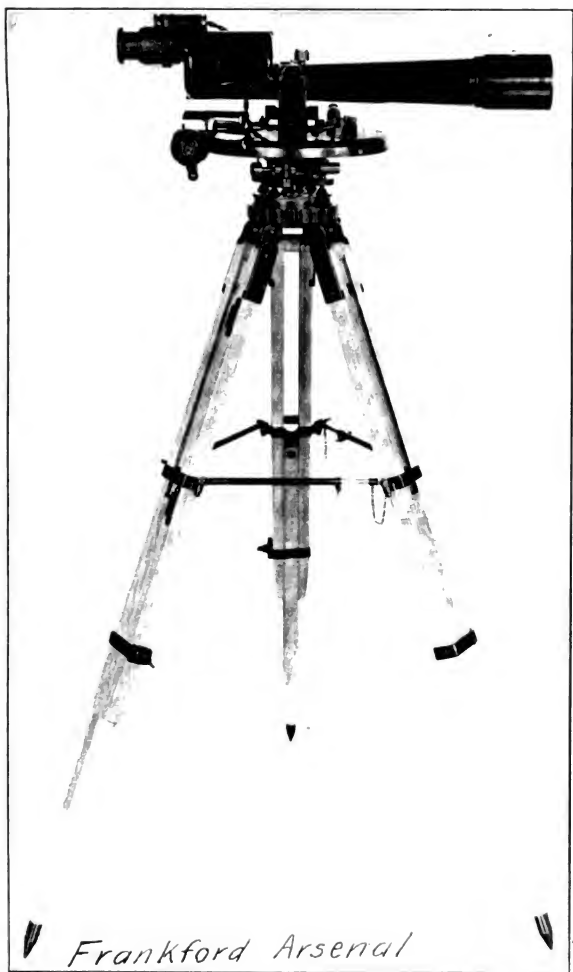
In accordance with this table, the following is the order of accuracy:

* Appendices C, C', C"; D, D' and D" not reproduced herein.

† Appendix E' not reproduced herein.







1. Warner and Swasey.
1. Frankford Arsenal.
2. Bausch & Lomb Optical Company.

Table III

Average error when worm was clicked, all observers.

W. S.	0°.0316
B. L.	0°.0395
F. A.	0°.0456

In accordance with this table, the following is the order of accuracy:

1. Warner & Swasey.
2. Bausch & Lomb Optical Company.
3. Frankford Arsenal.

Table IV

Average error, setting on 10 second interval, all observers.

W. S.	0°.0081
F. A.	0°.0097
B. L.	0°.0162

In accordance with this table, the following is the order of accuracy:

1. Warner and Swasey.
2. Frankford Arsenal.
3. Bausch & Lomb Optical Company.

Table V

Average error, in observation after 45 minutes continuous turning.

B. L.	0°.0055
W. S.	0°.0059
F. A.	0°.0682

In accordance with this table, the following is the order of accuracy:

1. Bausch & Lomb Optical Company.
2. Warner and Swasey.
3. Frankford Arsenal.

Table VI

Average mean variation, officers and enlisted men observing.

W. S.	0°.0012
B. L.	0°.0025
F. A.	0°.0079

In accordance with this table, the following is the order of accuracy:

1. Warner and Swasey.
2. Bausch & Lomb Optical Company.
3. Frankford Arsenal.

Table VII

Average mean variation, representatives observing.

W. S.	0°.0014
B. L.	0°.0023
F. A.	0°.0029

In accordance with this table, the following is the order of accuracy:

1. Warner and Swasey.
2. Bausch & Lomb Optical Company.
3. Frankford Arsenal.

Table VIII

Average mean variation when worm was clicked, all observers.

W. S.	0°.0012
F. A.	0°.0030
B. L.	0°.0032

In accordance with this table, the following is the order of accuracy:

1. Warner and Swasey.
2. Frankford Arsenal.
3. Bausch & Lomb Optical Company.

Table IX

Average mean variation, setting on 10 seconds interval, all observers.

W. S.	0°.0012
B. L.	0°.0017
F. A.	0°.0031

In accordance with this table, the following is the order of accuracy:

1. Warner and Swasey.
2. Bausch & Lomb Optical Company.
3. Frankford Arsenal.

Table X

Average mean variation, after 45 minutes continuous turning, all observers.

W. S.	0°.0007
F. A.	0°.0007
B. L.	0°.0021

In accordance with this table, the following is the order of accuracy:

1. Warner and Swasey.
1. Frankford Arsenal.
2. Bausch & Lomb Optical Company.

In making the accuracy tests the observers were shifted from instrument to instrument in order to equalize personal errors. The weather conditions were good and the results represent as great accuracy as may be expected in these instruments. The points used in making this test were a lighthouse and datum points for which a careful triangulation has been made.

The Board appreciates that the best criterion of the accuracy of such instruments is a shop test but is of the opinion that the accuracy test (mean error and mean variation) as conducted here is a true criterion of the type of instrument which will give the most accurate results when issued to the service, though the numerical values are greater than shop tests will show. It will be observed from the tables that the mean error and variation for each instrument are within the allowable error for a service base-end instrument.

The members of the Board used the instruments and observed their working during the test, and considered each in connection with the items of the program as set forth below.

1. *Inspection of the instrument, including examination of the general design, simplicity of construction, and facility of adjustment, clearness of field of telescope.*

The general design of the instruments, as shown by the photographs, is similar. Each has a worm interlocking with an azimuth circle by means of a spring permitting of engagement and disengagement, hundredths being read on a wheel. Each may be said to be of equally simple construction. The facility of adjustment is practically the same. Clearness of the field of the telescope was excellent with each, the Bausch & Lomb telescope being superior.

The Frankford Arsenal instrument has a special feature in that the telescope, reading window and micrometer wheel remain always in the same relative positions. This is a good feature of the instrument when used for instruction purposes but is not a matter of consequence when it is to be used as a station or base-

end instrument. The instrument has a bottom plate to keep out dust which is quite a good feature.

The Frankford Arsenal instrument required much more readjustment during the test than either of the others. (See Appendix F, Captain Jenks' letter.)

The Warner and Swasey and Bausch & Lomb instruments are similar in that the reading window changes with relation to the telescope at different orientations unless the entire instrument is shifted.

The leveling screws of the Bausch & Lomb instrument are far superior to those of the others and this instrument gives the impression of the highest grade workmanship.

The Warner & Swasey instrument is made to fit the present pier mounts of the service. The tripods of the Warner and Swasey and Frankford Arsenal instruments are very light; that of the Bausch & Lomb instrument is heavy and substantial and the others would not compare with it as a mount for using the instruments at temporary stations. The Board does not attach much weight to this as such use would be the exception rather than the rule, and is of the opinion that the Frankford Arsenal type of tripod will give satisfactory service.

2. *Measurements of powers of eyepieces, emergent pencils and fields of view.*

Powers of the eyepieces, diameters of emergent pencils, fields of view, and diameters of objectives were as follows:

Name	Power	Diameter Emergent Pencil	Field of View	Diameter of Object
Warner and Swasey	15	.20 inches	2°55'	3. inches
	24	.125 "	2°02'	3. "
Bausch and Lomb	11	.265 "	3°09'	3.14 "
	25.6	.1225 "	2°05'	3.14 "
Frankford Arsenal	14.4	.208 "	2°37'	3. "
	26.3	.114 "	1°42'	3. "

3. *Test of adjustment for collimation.*

The method of adjustment for collimation is the usual one, and it is the same for each instrument.

4. *Removal of optical parts for cleaning; reassembling and adjustment.*

Provision for the removal of optical parts was much the same in the Frankford Arsenal and Warner and Swasey instruments but provision was not made for this in the Bausch & Lomb telescope as that company does not advise this procedure. How-

ever, the representative told the Board that such provision could be made if desired.

5. *Test of errors of graduation.*

In the test of errors of observation, results of which are set forth in Tables 1* to 10*, the orientation was changed so that the same angles were measured in practically every 30° of the azimuth circle.

6. *Determination of amount of backlash in azimuth mechanism, and noting method of correcting same.*

Slight backlash developed in the Frankford Arsenal instrument from time to time during the test but neither of the others needed any adjustment in this respect. Readings were taken after the continuous turning of 45 minutes and the Frankford Arsenal instrument showed more backlash than either of the others, for which the backlash was scarcely perceptible. The method of correcting backlash was similar in all the instruments, to wit, by means of a spring, and a nut admitting motion in the direction of the axis of the worm.

7. *Test of illuminating system at night for crosswires and scales.*

The Frankford Arsenal instrument used an indirect method of lighting the crosswires and the scales. The illumination was not satisfactory on the crosswires, while that on the scales was satisfactory except for the defect mentioned below.

The illumination of the Warner and Swasey instrument was similar to that of the present depression position finder and is satisfactory except for the defect mentioned below.

The illumination of the Bausch & Lomb instrument was especially satisfactory except for the defect mentioned below. It used both a dimmer and a shutter for varying the intensity. It has, further, a special switch so that any or all of the lights may be thrown on at any time. The lights are operated by dry batteries attached to the instrument but provision could be made for their connection to 110-volt mains.

All the methods of illuminating the scales are especially defective in that they throw a bad glare into the observer's eye as soon as he withdraws it slightly from the eyepiece. A recommendation to provide against this defect is made below.

8. *Test of accuracy of observations for azimuth on fixed points in the daytime.*

The results of this test are set forth in Tables 1* to 10*.

* But one page reproduced herein. It is on page 19 of this JOURNAL.

9. *Test of accuracy of observation on fixed points at night.*

Test for accuracy of observation on fixed points at night was not made as the variation in the searchlight illumination caused such observations to be of little value in arriving at conclusions as to accuracy. Test for definition at night was made as follows: A boat went out and circled at various distances from the observing station, observations being taken with each instrument for each distance. The members of the Board concluded that there was practically no advantage in favor of any instrument for observing at night.

10. *Test of effect of shock of discharge from nearby heavy guns on adjustments of instruments.*

The test was not carried out, as the Board is familiar with the effect of shock of discharge on the present azimuth instrument and the construction of this is so similar to those tested that there is no question that the adjustment would not be affected by the shock of discharge.

11. *Test of adaptability for tracking and facility of taking readings on moving targets day and night.*

The test was made by observing various kinds of vessels at various speeds, both day and night, and if there is any advantage in this particular it is very slightly in favor of the Bausch & Lomb instrument.

12. *Test for definition in daytime; at night.*

The definition in day and at night was excellent for all the instruments, the Bausch & Lomb instrument having a slight advantage.

13. *Prior to the beginning of the test each representative will be required to submit to the President of the Coast Artillery Board proper credentials and on completion of the test will be required to state in writing either that he is satisfied with the conduct of the test or to specify in what particulars it was unsatisfactory to him, and whether or not he desires further test.*

* * * * *

It will be noted that the Warner and Swasey Company except optical parts in providing for interchangeability and that the Bausch & Lomb Optical Company absolutely decline to consider the question of interchangeability as required under General Provisions of the program, contending that such a requirement is contrary to accepted practice in making instruments of precision.

* * * * *

In the opinion of the Board the position of the Bausch &

Lomb Optical Company is more or less well taken. It will be noted that the Warner & Swasey Company desire \$34.00 per instrument, a total of \$1700.00 for this order (12.5%) to comply with interchangeability requirements set forth in the general provisions.

The Board does not believe that it is in the interest of the service to pay such a percentage for the possible utility of such a provision at some future date. Furthermore, while interchangeability may be specially desirable with some apparatus, it is believed that with this type better and cheaper service will result in the long run by not requiring it, and the Board recommends that interchangeability be not required.

The representatives were informed that this question of interchangeability was to be reported upon by the Board but to be settled when it came to the question of making contracts for the instruments.

In view of the foregoing, the Board recommends:

1. The adoption as the Model 1910, the Warner & Swasey Azimuth instrument as tested, with the following modifications:

(1) A bottom plate to keep dust out of worm gear.

(2) Removal of the front portion of the cover for hundredths wheel, according to photograph herewith.*

(3) Supply of a hood as part of the micrometer lamp bracket, according to sketch.†

(4) A screw and spring box for telescope clamp instead of two screws.

(5) An eyeshade for the telescope similar to that supplied the latest type D.P.F.

(6) Eyepieces of 10 and 15 power instead of 15 and 25. (It may be argued that a 10 power eyepiece will give too large an emergent pencil, but the Board is of the opinion that for night, and hazy weather service, it is the proper power for the best results.)

2. The purchase of 55 of these instruments, in accordance with the preamble to the specifications herewith.

3. The manufacture of such tripods and pier mount attachments as may be necessary at Frankford Arsenal.

The Board recommends, that an allotment be made for the manufacture at Frankford Arsenal of another instrument embodying the improvements suggested in the letters hereunto appended, marked F, with a view to its test against the Model 1910 instru-

* Not shown in illustration.

† Not reproduced herein.

ment when a new model is to be brought out, and that the present Frankford Arsenal instrument be modified in accordance with letter F herewith, provided with a hood similar to that recommended for the Warner & Swasey instrument, and issued to this post with a view to its observation in service by the Board.

The Board recommends also that the Government purchase the Bausch & Lomb instrument, with an attachment for pier mount, and issue it to this post for observation in service, by the Board; provided the Bausch & Lomb Optical Company will make the following modifications without additional cost:

1. A hood for lamp bracket similar to that recommended for the Warner & Swasey instrument.

2. Enlargement of the reading window so as to see two numbered degree marks; for example* :—

3. The adaptation of the lamps to 110 volt circuits.

The Board recommends further that manufacturers be notified that instruments will be tested in competition with the service instrument at any time they are willing to submit an improved type at their own expense. The type of instrument, thus submitted, if successful in the competition, to be recommended as the standard service instrument.

(Signed) RICHMOND P. DAVIS,
Major, Coast Artillery Corps,
President.

A true copy:

CLAUDIUS M. SEAMAN,
Captain, Coast Artillery Corps,
Recorder.

APPENDIX "A"

COMPETITIVE TESTS OF AZIMUTH INSTRUMENTS FOR USE IN COAST ARTILLERY SERVICE

It is the intention of the War Department to expend during the next fiscal year the sum of \$15,000 in the purchase of azimuth instruments for Coast Artillery purposes, and a competitive test of such instruments will be held at Fort Monroe, Va., beginning about September 1, 1909. In case the test develops an instrument satisfactory in all respects an order for the successful instrument will be placed, amounting to approximately \$15,000. This statement is not to be construed as obligating the Government in any way but as significant only of present intention.

* Illustration showing this not reproduced herein.

*Specifications for Instrument to be Submitted for Test**The Telescope:*

1. To be of the erect image type with an objective having a clear aperture of 3 inches. In case prisms are used in erecting the image the Porro combination will be granted the preference.

2. To be furnished with two eyepieces of 15 and 25 powers or with a single variable eyepiece with minimum power not greater than 15 and maximum power not less than 25.

3. The fields of view to be as large as may be consistent with the other optical properties. The diameter of the emergent pencil from the low power eyepiece should at least equal the diameter of the pupil of the average eye.

4. The optical system to be free from chromatic and spherical aberrations and from distortion and curvature of the image. Definitions to be clear and distinct and the field of view evenly illuminated.

5. To be provided with vertical and horizontal cross wires in the plane of the image of the objective when focused on any object at a range of 400 feet or greater, the cross wires to be the equivalent of the spider web in dimensions and mounted so that they will permit of adjustment for collimation.

6. The cross wires to be illuminated for night observations and provision made for varying the intensity of the illumination by mechanical means.

7. The objective to be provided with a sunshade and the eyepiece with an amber ray filter.

8. All lenses and prisms to be mounted accurately and substantially and so as to permit of the necessary adjustments.

9. All optical parts to be readily accessible for cleaning and for adjustment or for substitution of parts.

The base:

10. To be provided with a means of carrying the telescope that will permit of its rotation in a vertical plane not less than 15 degrees on either side of the horizontal and of rotation in a horizontal plane through 360 degrees by rapid and slow motion or to the reverse without affecting adjustment.

11. To be provided with an azimuth circle and attachments essentially free from backlash that will permit azimuth readings to one-hundredth of a degree readily and practically without liability to error.

12. To be provided with suitable means for the quick and accurate orientation of the instrument.

13. To be provided with means for leveling accurately, preferably four leveling screws and two adjustable spirit levels with vials ground for a movement of .1 of an inch for 30 seconds change in elevation, and mounted on the base with their axes at right angles to each other.

14. All mechanisms and especially the spindle to be substantially and accurately mounted.

Tools, accessories, etc.:

15. All necessary tools and accessories, a substantial tripod mount with adjustable legs, and a suitable chest for the instrument, to be provided with each, the tripod mount to be provided with adjustable braces as shown on page 243, Artillery Journal, November-December, Fort Monroe, Va., 1908.

Illumination of scales:

16. Suitable means to be provided for illuminating all scales of each instrument. An indicating switch to control all lamps to be mounted on the base. The lamps to be of either 36 or 110 volts. The wiring to be either No. 16/34 black braided silk covered incandescent electric lamp cord, insulated with a 30% rubber compound 1-64 inch thick over a single cotton insulation, or a No. 14 B. & S gauge Habirshaw core wire or equal.

Finish:

17. All exposed metal parts to be finished so they will not corrode.

APPENDIX "B"

PROGRAM OF TESTS

1. Inspection of the instrument to include an examination of the general design, simplicity of construction, facility of adjustments, clearness of field of telescope.

2. Measurements of powers of eyepieces, emergent pencil and fields of view.

3. Test of adjustment for collimation.

4. Removal of optical parts for cleaning; reassembling and adjustment.

5. Test of errors of graduation.

6. Determination of amount of backlash in azimuth mechanism, and noting method of correcting same.

7. Test of illuminating system at night for cross wires and scales.

8. Test of accuracy of observations for azimuth on fixed points in the day time.

9. Test of accuracy of observations for azimuth on fixed points at night.

(Note: The observations to be taken under 8 and 9 to be tabulated and the mean variation and error of observation for each set to be computed.)

10. Test of effect of shock of discharge from nearby heavy guns on adjustments of instrument.

11. Test of adaptability for tracking and facility of taking readings on moving targets day and night.

12. Test for definition in day time; at night.

13. Prior to the beginning of the test each representative will be required to submit to the President of the Coast Artillery Board proper credentials and on completion of the test will be required to state in writing either that he is satisfied with the conduct of the test or to specify in what particulars it was unsatisfactory to him, and whether or not he desires further tests.

General Provisions

At the time the instruments are submitted for test contractors will be required to furnish information in writing as to the cost of the instrument in lots of 25, 50 and 100. In making an estimate of cost the following should be considered: All parts of the instrument furnished by the contractor must be interchangeable except that lenses and prisms may not be interchangeable among themselves but must be fitted to a cell or holder which is interchangeable so far as those surfaces are concerned by which they are secured to the body or other parts of the telescope. Instruments purchased under contract will be tested for interchangeability by taking parts assembled into various instruments and making up an instrument which will then be carefully tested. The estimate of cost will include the instrument, a suitable chest, accessories, all properly marked, packed, and delivered F. O. B. cars at contractor's works; the cost of tripods and attachments for pier mounts will be submitted separately. The contractor will be required to furnish the Ordnance Department, without cost, tracings giving an assembled view of instrument and details of all parts and accessories, the tracings to conform to Ordnance Department standards as to size, markings, etc.

All instruments manufactured will be subject to inspection during manufacture and to shop tests to be made by an inspector under the Chief of Ordnance.

Any contract made for future delivery of instruments will be subject to the usual provisions governing contracts, manufacture, test and inspection and to such specifications as are found advisable to insure high grade workmanship, interchangeable parts, and the furnishing of the exact instrument adopted and ordered.

[Appendices C, C', C'', D, D', D'', omitted.]

APPENDIX "E"

GENERAL DESCRIPTION OF 3-INCH AZIMUTH INSTRUMENT THE WARNER AND SWASEY COMPANY, CLEVELAND, OHIO

The telescope is 3" aperture and 24" focal length, the image of the object being erected by means of the Porro Prism System.

It is provided with two eye pieces magnifying 15 and 25 diameters respectively, giving field of 2 degrees and 54 minutes, and 2 degrees and 5 minutes, respectively.

Each eye piece is provided with a ray filter in the form of a revolving disk having 2 amber shade glasses of different density of color.

To provide for collimation, the telescope with its trunnions is reversible in the carrying yoke.

The azimuth circle is divided into single degrees and figured every 10 degrees from 0 to 360. It is made solid with the taper vertical spindle which carries the yoke, which in turn supports the trunnions of telescope itself. This circle is $9\frac{1}{2}$ " outside diameter having 360 teeth cut in its circumference.

Tangential to this circumference and engaging with its teeth is an accurately ground worm screw solid on a shaft having a drum divided into 100 parts, enabling the observer to read direct to one-hundredth of a degree. This worm shaft is carried by a special swinging yoke, having adjustable taper bearings so that backlash is avoided. The worm threads represent an angle of 60 degrees and have rounded edges so that they cannot be injured by rough usage. The worm can be disengaged or connected at will, thus giving quick or slow motions as desired. To insure extreme accuracy to this worm, it is finished by lapping, after the manner of finishing micrometer screws.

The telescope has 20 degrees elevation and the same depression, and is provided with a clamp and slow motion for convenient setting in altitude.

To provide for a direct reading of angles, a special clamp and slow motion enables the observer to set the telescope on any desired target or fixed point, while the azimuth circle reads 0.

Two cross levels having divisions of 30 seconds are mounted at right angles to each other on the base plate. Four knurled head leveling screws are applied in the usual manner.

The base of the instrument is threaded to fit the pier mounts which are standard in your department.

Electric illumination is provided for reading the azimuth circle and dial, also for illuminating the cross wires in the field of the telescope. The latter is provided with a shutter to moderate the density of light.

The electric lamps are of 2 candle power and require from 34 to 36 volts. They are wired in parallel. A suitable switch is mounted on the cover plate of the azimuth circle for the purpose of operating the electric lights.

The instrument is properly boxed for safe transportation.

THE WARNER & SWASEY CO.

[Appendix E' omitted.]

APPENDIX "E"

GENERAL DESCRIPTION OF 3-INCH AZIMUTH INSTRUMENT

BAUSCH & LOMB OPTICAL COMPANY

Fort Monroe, Va., November 5, 1909.

The President,
Coast Artillery Board,
Fort Monroe, Va.

Sir:—

We cannot entertain interchangeability of various parts of azimuth instruments, as it is too costly and impracticable.

* * * * *

Referring to the competitive test of azimuth instruments, I desire to submit the following description of our instrument.

The diameter of azimuth circle is fifteen (15) inches.

The telescope has a triplet objective of eighty (80) millimeters clear aperture.

The eyepiece is of the revolver type, that is, the two eyepieces of different magnification are mounted on a table which turns upon a center. Either eyepiece may be brought into position by turning the table as indicated by the index line. The

advantage of the revolver eyepiece is that both eyepieces are always on the telescope and the magnification can immediately be changed from one to the other.

The magnification of the two eyepieces in the instrument are 11X and 23.25 X, but in future orders they can be made 15X and 25X.

The cross wires are etched upon glass. The danger of their breaking from shock is thus lessened.

The illumination of the cross wires and azimuth circle is controlled by a four-point switch, which works as follows:

1st position. Only cross wires are illuminated.

2nd position. Only azimuth circle is illuminated.

3rd position. Both the cross wires and azimuth circle are illuminated.

4th position. Neither are illuminated.

The illuminator to the cross wires is provided with a shutter. This allows the illumination of the wires to be cut down without affecting the illumination on the circle.

Very respectfully,

J. L. SAEGMULLER,

Representing the Bausch & Lomb Optical Company.

APPENDIX "E"

* * * * *

MEMORANDUM CONCERNING AZIMUTH INSTRUMENT, PILOT, MANUFACTURED AT FRANKFORD ARSENAL FOR TEST BY THE ARTILLERY BOARD

The telescope:

The aperture of the objective is 2", its focal length is 30". The power of the low power eyepiece is 14.55 and of the high power eyepiece is slightly over 26. The field of view of the low power eyepiece is 2°.65 and of the high power eyepiece 1°.62.

The lenses and prisms are rigidly and simply mounted and easily accessible for cleaning. The definition of the telescope is considered superior and the illumination of the field is a maximum. The adjustment of collimation is made by moving the reticule ring. The collimating screws are readily accessible.

Parallax may be removed for a range of about 200 feet and over. The diameter of the reticule is ".0005. Simple and effective means are provided for illuminating the cross wires. The illumination of each wire may be independently adjusted and the inten-

sity of light on both wires varied by mechanical means. The lamps are 2 candle power, 110 volt. No resistance is required for use on 110 volt circuits.

The base:

The platen and the azimuth circle are mounted on independent centers. The wear of the centers is thereby distributed over independent surfaces. Special metals to resist wear have been used in all parts of the base. The center is substantially and accurately made. The azimuth circle is not only notched but also hobbled so as to secure greater bearing surface between the worm and gear and consequently a longer accurate life.

The telescope is revolved and the angle of rotation measured by a worm and worm gear. Special facilities have been secured for the cutting of accurate worm gears. The maximum error of the azimuth circle is +20 seconds. Easily accessible means are provided for removing backlash from the worm and gear and for curately changing from rapid to slow motion or the reverse. All flat springs have been eliminated.

The spirit level vials are ground for a movement of 30 seconds change in elevation for the movement of the bubble of .1 inch. The mountings for the level vials are specially designed for the levels to retain their adjustment.

The worm and gear and centers are entirely enclosed in dust proof boxes. All parts of the worm and gear or the centers may be readily disassembled and cleaned. Oil cups are provided for lubricating all bearing surfaces.

The tripod:

The tripod has adjustable legs and adjustable braces to stiffen the legs. The tripod possesses the stability requisite for an accurate instrument.

The necessary tools and accessories are provided for adjusting or disassembling the instrument.

* * * * *

Frankford Arsenal, Philadelphia, Pa.,
November 8, 1909.

President of the Artillery Board,
Fort Monroe, Va.

Sir:—

1. Referring to my letter F 21-186 and to your inquiries regarding cost of azimuth instrument in accordance with design submitted to you for test, I have the honor to inform you that the

cost price quoted includes 7.8 per cent. to cover administrative, capital and depreciation costs which are not directly charged to the appropriation covering the manufacture of the instruments, but which are included for comparison of costs with other manufacturers. The price quoted also includes the cost of inspection.

* * * * *

Very respectfully,

(Signed) GEORGE MONTGOMERY,
Major, Ordnance Department, U. S. A.,
Commanding.

APPENDIX "F"

Fort Monroe, Va., November 4, 1909.

The President, Coast Artillery Board,
Fort Monroe, Va.,

Sir:—

In reference to the test of azimuth instruments, I have the honor to submit the following notes and remarks regarding the Frankford Arsenal instrument.

During the test it has been found that the light from the index disc reaches the observer's eye. This may be eliminated by modifying the lamp bracket, which can readily be done.

The variation of the quantity of light reflected on the cross wires does not appear large enough. The variation can be increased and a better regulation of the light on the cross wires secured by slight modifications in the details of construction. On account of lack of time this device was not as thoroughly tested before shipment as is ordinarily the case with type instruments. By a modification of the diaphragm and the apertures reaching to the reticule chamber and slight changes in other details, a more satisfactory illumination of the cross wires can be secured.

The azimuth circle clamp has not sufficient power to clamp the circle satisfactorily. This defect can readily be remedied by a modification of the clamping shoe and screw. If desired, the plunger and spring can be replaced by a screw.

If a slow motion screw for changing the elevation is desired, it can be added. Also, open sights for aligning telescope can be provided.

The apparent fields of the eyepieces are approximately 40°. This may be increased to 45° without appreciably affecting the other optical qualities of the telescopes. The field of view is the

apparent field of the eyepiece divided by the magnification. Thus, for a power of 15 and an approximate field of 45° , the field of view would be 3° .

The powers of the eyepieces may be modified without affecting the estimated cost quoted.

If desired, a rubber tip may be added to the eyepieces to form a cushion for the observer.

For observation over water from which the sun's rays are brilliantly reflected, a dark ray filter, in addition to the amber glass ray filter, may be advisable. If so, the details of telescope may be modified to incorporate it.

The modifications referred to above will not affect the estimated cost already quoted by Frankford Arsenal.

Respectfully,

G. F. JENKS,

Captain Ordnance Department, U. S. A.,
Representing Frankford Arsenal.

APPENDIX "G"

COMPETITIVE TESTS OF AZIMUTH INSTRUMENTS

No. of Observation	Set No. 1			Set No. 2					
	Target: Bug Light			Target: Datum Point No. 4					
	Orientation: Bug Light 20°			Orientation: Bug Light 20°					
	Angle: 0° to target			Angle: 30°.41 to target					
	Setting to be read:			Setting to be read:					
			W. S. 20°						W. S. 50°.41
			B. L. 20°						B. L. 50°.4134
			F. A. 20°						F. A. 50°.4066
Warner & Swasey				Bausch & Lomb			Frankford Arsenal		
Readings	Error	Variation	Readings	Error	Variation	Readings	Error	Variation	
431	20.00	.0000	.0000	19.9975	.0025	.0000	19.9975	.0025	.0010
432	.00	00	00	.9975	25	00	.9975	25	10
433	19.9975	25	25	.9975	25	00	.9975	25	10
434	20.0025	25	25	.9975	25	00	.9950	50	15
435	.00	00	00	.9975	25	00	.9975	25	10
436	.0025	25	25	.9950	50	25	.9975	25	10
437	.00	00	00	.9975	25	00	.9975	25	10
438	19.9975	25	25	.9975	25	00	.9950	50	15
439	20.00	00	00	20.00	00	25	.9950	50	15
440	.00	00	00	19.9975	25	00	.9950	50	15
Total	200.0000	.0100	.0100	199.9750	.0250	.0050	199.9650	.0350	.012
Mean	20.0000			19.9975			19.9965		
M. V.			.0010			.0005			.0012
M. E.		.0010			.0025			.0035	

MILITARY EFFICIENCY

BY CAPTAIN WILLIAM H. MONROE, COAST ARTILLERY CORPS

Much has been said of late for and against various schemes for promoting efficiency in the army; and from the free and easy way in which the terms "elimination" and "selection" are often used in these discussions, one might conclude that elimination and promotion by selection were quite the proper thing or might become so by no great twist of the imagination. Indeed, one might almost conclude, from a perusal of some of the proposed schemes, that relative age is quite a sufficient criterion, and that it is essential to eliminate for age regardless of anything else, in order that younger and presumably better men may take the places thus made vacant. But is it not carrying presumption too far to assume that even in a majority of cases the younger men are more efficient? Why presume at all? There are other and more vital aspects of the question; and these should be given their just weight in the determination of military efficiency.

Elimination of the unfit is desirable; but there is no place in our service for any form of elimination that would render uncertain and doubtful the aspect of an officer's career; or make him lose for a moment that confidence in his future which is the mainstay of his contentment with a life that offers so few of the attractions of civil pursuits. Artificial elimination is undesirable, from every point of view; natural elimination, by the means at hand, is not only desirable but necessary, thereby leaving in the service only those who are worthy of promotion.

Nothing could be more unfortunate and undesirable in the military service than a standard of efficiency based on insufficient evidence. Military reports, in dealing with an officer's efficiency, should be so comprehensive as to include details pertaining to all three sides of the question.

The factors that enter into the product of military efficiency are moral, intellectual, and physical; and just what weight should be given to each of these three sides to the question of military efficiency is worthy of the closest study.

No less an authority than Napoleon has stated that the moral

factor is to the physical as three to one; and yet, this is the one faculty which is the most elusive, the most mysterious, the most difficult to gauge. A soldier may be accounted excellent as an officer in peace or in the lower grades where less demand is made on his ability, and yet fail utterly when forced to rely on his own responsibility.

Napoleon said: "It is rare and difficult to find in one man all the qualities necessary for a great general. What is most desirable and immediately brings anyone to the front, is, that the understanding and the attainments should be in equilibrium with the character and the courage. If his courage is much superior to his attainments, a general attempts what is beyond his capacity, and, on the contrary, if his character and his courage remain below his intelligence, he does not dare carry out his plans."

Courage is a moral virtue, a mysterious force working in the minds of men, that determines them to overcome the strong natural instinct of self-preservation and to endure self-sacrifice even, if need be. "In all battles," said Napoleon, "the time comes when the bravest soldiers, after having made the grandest efforts, feel disposed to run away. This terror is caused by a want of confidence in their courage; it requires only the slightest cause, a mere pretext, to restore to them their courage; the great art is to produce it." That is the secret of the born leader; it is a characteristic of the man and cannot be acquired by a study of texts; but if it exists in some men naturally, it can be developed by increased knowledge and by a greater capacity for sympathy as the years go by.

It is obvious from a study of the Japanese successes in war, that moral forces entered largely into all their operations. The Japanese youth are thoroughly disciplined, lofty ideals are constantly before them, and their moral training is such that they are inspired with an extraordinary patriotism, linked with self-restraint, endurance, cheerfulness, and a readiness for self-sacrifice, should occasion demand it.

The inference to be drawn is that in estimating military efficiency more weight should be given to personal characteristics and demonstrated ascendancy over the minds and wills of men and less weight should be attached to mere professional knowledge and ability to pass good examinations.

Yet, it must be admitted that an army officer should possess considerable knowledge in addition to a strong character and high moral qualities. He must necessarily be intellectual; but to be successful as an officer of the army requires a higher develop-

ment of moral and physical qualities than is necessary to be successful in any other profession in life.

An officer's standing ought not to depend too much upon mere cleverness or intellectual capacity. Too often the man with great force of character and high moral faculties, but less intellectual, is handicapped and accounted the inferior of the more clever man, with his purely intellectual attainments. Brains, knowledge, and a splendid educational equipment are totally inadequate to success in the army, if unaccompanied by high moral qualities. We need turn over but few pages of history to be convinced of this; and yet, to be a real leader, a man must inspire confidence, and an officer without sufficient professional knowledge would not inspire confidence. Therefore, a fair examination test is a necessary requirement.

In time of peace, an officer's efficiency should be judged according to the parable of the talents; it is not what a man could do but what he has done and his manner of doing it; that is what counts. But the chances are that being like other men prone to error he will of necessity make mistakes. Indeed, Turenne said that when a man has made no faults in war, he has not made war long. But Napoleon said: "In the practice of war, the game is always with him who makes the fewest mistakes." And that is the criterion by which military efficiency should be judged, in time of peace, as well. Hence, the value of intellect combined with force of character in a man, who must face his mistakes and profit by his errors, if he would keep pace with the progress of his profession.

It is axiomatic that the whole art of war consists in producing the greatest physical effect at a decisive point; but there is a vast difference between the theory and its practical application; and to apply it in war, men of rare qualities are needed, men who are in close touch and sympathy with human nature, that spirit of men so easily affected, so emotional and yet so strong, so readily elated and yet so easily discouraged. Napoleon was master of the art of working upon the emotions; the mere fact of his presence was sufficient to rally his troops and restore their courage.

Men follow their officers. This calls for physical strength and courage. It was not alone the name of Napoleon that filled his troops with courage, but his presence in person on the battlefield. Military campaigns are of necessity arduous; and the requirement that officers keep themselves in excellent physical condition is a wise and far-reaching measure. It is not too much to expect an officer to keep himself, by judicious training, in

health and strength, ready at any time to take the field with his troops.

To summarize: duty, justice, honesty, truthfulness, unselfishness, patriotism,—all these and more, should form a part of the moral equipment of the soldier in every grade from the general to the mere private; and more weight should be given to such high moral qualities than to mere intellectual or physical qualities. Nothing short of the test of actual war can bring out the higher qualities of courage and leadership; yet that very fact demands that in estimating military efficiency greatest weight should be attached to the moral virtues, which, in peace as in war, have always been to the physical as not less than three to one.



GRENADES

BY MAJOR H. L. HAWTHORNE, COAST ARTILLERY CORPS.

It is altogether probable that the invention of the grenade was co-existent with that of the shell, and that it was first used in 1594. It is not impossible that the idea of throwing destructive objects by hand at an enemy in close proximity may have been suggested by the fire-pots of the Greeks. Those weapons possessed no explosive action, so far as we now know, although they were used against the personnel of besieging forces. Their particular employment, however, was in naval actions, for the purpose of setting fire to opposing ships. They are said to have been invented by an engineer named Callinicus, of Heliopolis, who used them with so much skill and effect during a naval engagement that he destroyed a whole fleet belonging to the enemy, upon which were embarked 30,000 men. This statement, however, may be one of those which justified the major premise of the Platonic syllogism beginning, "All Greeks are liars."

During most of its history, the grenade appears as a weapon to be employed essentially in defensive siege operations. Its weight and caliber varied in accordance with the part of the defenses in which it was used. In James' Military Dictionary, originally published in 1802, are given some dozen weights and calibers of grenades, varying from sixteen pounds to a quarter of a pound. During the 17th Century there seems to have been given certain tactical consideration in their use in war, such as the selection and organization of certain picked men who were carefully trained for active operations. After this period their offensive quality compared with that of the musket gradually relegated their employment to sappers, and finally they made their appearance at long intervals, usually in response to the demands of prolonged sieges.

Major James, referred to above, of the Royal Artillery Drivers, laments their disappearance and says: "Grenades have unaccountably sunk into disuse; but we are persuaded there is nothing more proper than to have grenades to throw into the midst of the enemy, who have jumped into the ditch." His designation of

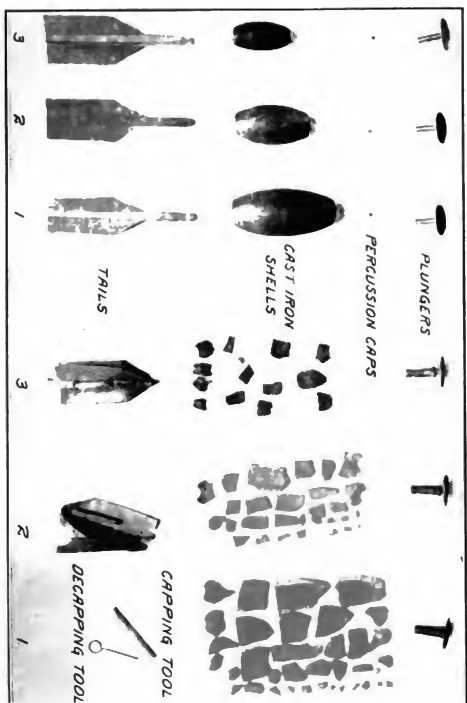


Plate I. Old model United States hand grenades, 1861-65.

the fitness of things by the expression "more proper" is quite in keeping with the cold-blooded expectation of an officer of field artillery. Nevertheless, military history takes flattering notice of their life-taking qualities as late as the siege of Sebastopol where both combatants expended several thousand of them. A large quantity was made by us during the Civil War, but the writer is unable to state whether they were ever used by troops in the field. If they did not disturb the enemies of the Federal armies they have at least succeeded in annoying the officers who have carried them on their returns for forty years.

There was another field of usefulness for the grenade and one in which it maintained its place for a more continuous active period and that was on board ships of war. They were used by ships' crews in "boarding" or "repelling boarders" until ships ceased to range alongside in a maneuver designed to bring the combat to a climax. These grenades were of the hand type and were distributed on maintop, poop, foretop and forecastle. The budge or grenade barrel in which they were carried was made in the form of a frustum of a cone, the small end up and open and the mouth closed with leather or painted canvas drawn together like the old-fashioned purse. In these were placed the grenades, loaded and primed; and when the ship was cleared for action, a budge barrel containing 25 grenades was carried to each top and two to each castle, gaugeway and poop.

These grenades as well as those used on land, were half filled with powder and exploded by means of a fuze inserted in a wooden fuze holder, and made in lengths to burn 25 to 30 seconds. The fuze composition consisted of five parts priming powder, two parts sulphur and three parts saltpetre. On the top of the fuze, for igniting it, was secured a match of cotton threads dipped in a burning composition.

In consequence of the changing methods of attack by field troops, brought about largely by the increasing precision and range of muskets and field artillery, the grenade was withdrawn from the effective equipment of armies, finally disappearing into the shadowing and forgotten corners of arsenals and depots. The opening out of the battlefield, particularly in depth, was not the formulated lessons of actual combat, but the dictum of modern writers of tactics, who had convinced themselves that in the sublimation of human nerves, largely brought about by the increasing strains and complications of modern life, the time had gone by when civilized men could meet on the battlefield in the fierceness of savage contact.

The Russo-Japanese war—that mine of lurid military suggestion—brought to the surface, among other forgotten things, the ancient and honorable grenade. The final battle line, in the hands of men not inculcated with the principle of an inalienable right to live, was brought up to within easy grenade range. One combatant being a mere imitator of the ultra-modern military German and the other the victim of self-confessed military neglect, both found themselves at this critical moment obliged to cast about hurriedly for the weapon which every one had been insisting had passed into the limbo of oblivion. The use each made of the improvised grenades on the blood-stained slopes and ditches of the Port Arthur defenses, caught the eye of the foreign military observer and there was much rushing about in feverish anxiety to keep pace with the latest developed methods for winning victories. Arsenals yawned and gave up dust-covered objects, long before thought dead; drill regulations were thumbed in an effort to modify them as so to accommodate the grenade; inventors crowded on the scene presenting to the unwilling experimenter a quaint variety of grenades, each said to be warranted not to destroy its friends.

Let us first review briefly the career of the grenade in Manchuria, before introducing the present condition of its development.

The accounts of the Russo-Japanese War disclosed the fact that on many occasions both sides used hand grenades, may of them the creation of the necessities of the moment and often constructed on the field of battle. This necessity, however, brought about serious efforts on the part of the ordnance supply departments of both armies to equip troops with carefully designed grenades of the hand throwing type. Naturally the construction of grenades by the troops themselves was on the simplest lines and from material most immediately available.

The need for such a weapon received a more significant meaning among the Russians, because of the generally defensive character of their tactics. At least, the occupation of prepared positions and their persistence in awaiting attack was much more marked with them than with their adversaries. This fact, added to the stubbornness with which Japanese attacks on works were pushed home, in violation of preconceived ideas of the possible in modern warfare, brought about the revival of the grenade with a suddenness that made its careful and scientific development impossible.

The first efforts on the part of the Russians took the form of

gathering unburst shrapnel cases, each weighing about three pounds, in which were packed two cartridges of gun-cotton having fulminate pellets for their detonation. These primers were discharged by means of a Bickford fuze, whose length outside the case, about 6 inches, was made to burn six or seven seconds. The calculation of time of burning was based upon one second to ignite and throw it, four seconds for time of flight, and one to two seconds on the ground, too short a time to allow of its being picked up and thrown back at the owners. Where it was desirable to prolong the burning, a hempen fuze was substituted for the Bickford. A fair fragmentation was the result of this size of charge. Fairly reliable reports indicate, however, that the estimated burning which would not allow time for its unfriendly return by the hands of the enemy was too short or else that fuzes, as with us, were troublesomely uncertain; for it is said that frequently these missiles were tossed back and forth until one side or the other became the victim of its activity, with an equal likelihood of its being the original owner.

These grenades were used in both the attack and defense. In the attack the purpose was to open gaps in crowded trenches to enable the assailants to use their bayonets effectively. Their use in the scattered fighting in villages was not uncommon and said to be quite effective. In the defense, they were used to search out dead spaces where the assailant could pause for breath and to assemble for the final rush. They thus gave an entirely new and ghastly meaning to the term "dead space."

The 37 and 47 mm. cartridge cases were used at Port Arthur in the manufacture of grenades; and common shell, with lighted time fuze, were thrown by hand or rolled down the slopes among the assaulting troops. The limited range of the hand throwing types suggested the need for more powerful means for propelling grenades, and several improvised devices were constructed to meet this requirement. For example, bombs were made from empty 15 cm. cartridge cases, filled with gun-cotton and scrap-iron, and fired from small iron mortars. Smaller grenades were fired from wooden mortars hooped with iron, or from 47 mm. guns, using small charges of powder. In the latter the grenade was equipped with rocket sticks inserted in the gun. Considerable execution is said to have been produced by these home-made projectiles; and on several occasions their destructive effects forced the Japanese to abandon their advanced trenches. Efforts were made during the progress of the war to provide improved designs of grenades, but as a rule the combatants preferred to

continue the manufacture of the more primitive types from material immediately available.*

The Japanese made use of similar grenades in their assaults, but later on the troops were supplied with one designed primarily as a hand grenade, from the description of which several were manufactured by us and tested in 1907. These tests consisted in dropping the grenades to ascertain their safety in handling and in transportation, and to note the effectiveness of fragmentation. They were variously charged: with black powder, powdered picric acid, explosive D, and "saw-dust" gun-cotton. The grenades, empty, weighed 14 ounces, and the bursting charge from 4 to 6 ounces. The experiments showed that a positive safety catch should be provided for handling, as the grenade will be exploded by a drop of only twelve inches on a hard surface. The design was defective in several other respects and it was noted that usually the lead missile belt, designed to break up into 28 slugs, merely split and became detached in two strips by the force of the detonation. Recommendations were made at this time to continue investigation along the lines suggested by this grenade and in consequence two designs were made, improving on the Japanese form in some respects but retaining what was understood to be their form of detonator and the means for its action and security. In one design the grenade consisted of a tin case, lined with paper, and of the form and dimensions clearly shown in the

* The illustration showing the various forms of extemporized Russian and Japanese grenades is reproduced from the "Reports of Military Observers during the Russo-Japanese War," Part III, No. 8. A, B, G and K are old cast-iron shells; C, a 37 mm. rapid fire cartridge case; D, N and H are different forms of tin cans containing explosive; L and M are fuzed dynamite cartridges and slabs of gun-cotton; F is a rapid fire cartridge case, with a rifle cartridge case containing a friction primer soldered to the outside; a torpedo war head arranged to fire by percussion and propelled by a light charge from a torpedo tube. The Japanese bomb gun, with its tin-can grenade, is shown, together with their latest development of hand grenade, not used at Port Arthur but in subsequent operations in the field. The illustration shows quite clearly the mechanical arrangement of this hand grenade. In actual use the primers were carried by the non-commissioned officers, who issued them to the men carrying grenades just before their use. They were made wholly from materials obtained locally, the primers and mealed gun-cotton coming from the spoils of Port Arthur.

A mortar grenade was improvised for firing from a rapid-fire 147 mm. navy gun mounted on a wheeled Chinese carriage whose construction permitted an elevation of 45° or more.

The grenade was a sheet-iron cone to whose base was attached a wooden rod designed to enter the bore. At the lower end of this rod was secured a lead ring for its protection against shock of discharge. To assure steadiness in flight a circular piece movable along the rod was added and to this were attached flanges which acted like the feathers of an arrow. This ring rested on the muzzle of the piece and on discharge slipped back to the rear end of the rod. A percussion fuze was used, with a dry gun-cotton primer. The propelling charge varied from $\frac{1}{2}$ to $\frac{1}{4}$, the bursting charge.

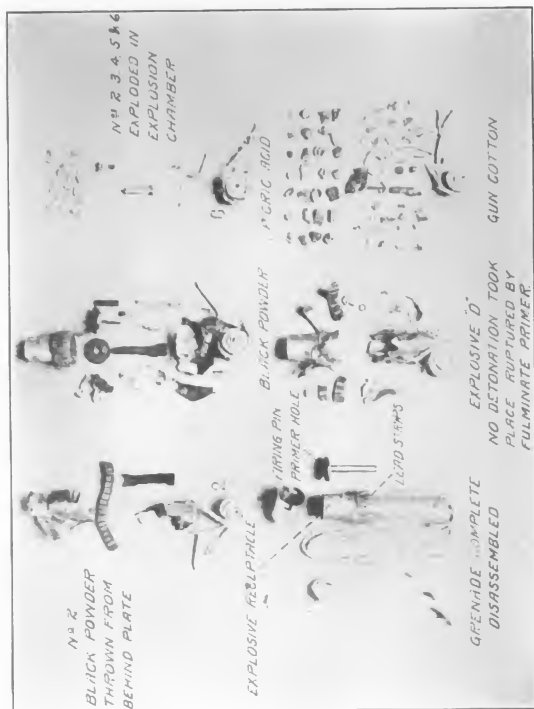


Plate III. Reproduction of Japanese design of hand grenade, showing generally imperfect fragmentation.

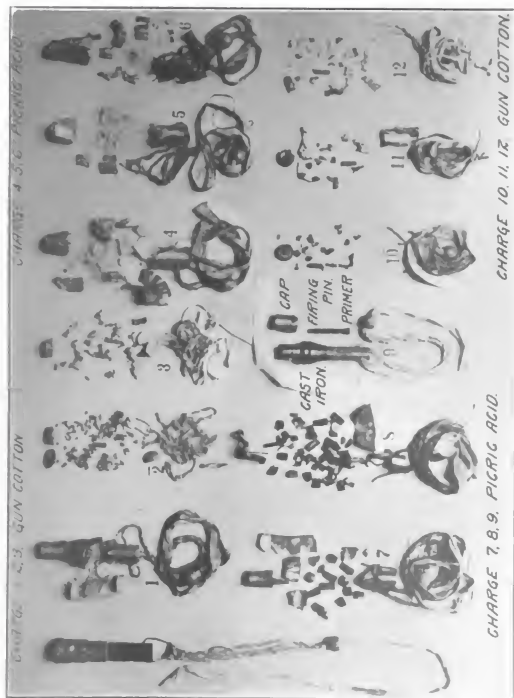


Plate IV. Improved Japanese design.
Practice dummy shown in upper left-hand corner of illustration.

drawing. The grenade, complete, weighed 8792 grains (about 1½ lbs.), of which 2187 grains was the picric acid charge and 479 grains the fulminate primer. The firing pin was secured in a tin cap to which a simple safety device was attached. In transportation this cap was packed separately, thus securing the primer against accidental discharge. When carried on the belt this cap was turned so as to engage a pin on the body of the grenade in a hole in a spring strap soldered to the cap. When about to be thrown the cap was revolved, allowing the pin to come opposite a weakened section. On striking, this cap was driven upward, permitting the firing pin to strike the primer. Three cords were attached to the base, united in a knot for easy gripping; and a ribbon of cotton prolonged these, to insure steadiness in flight and the certainty of striking head on.

The second design was of the same general form, except that the leaden missile belt, which provided the material in fragmentation, was replaced by cast-iron. This type weighed about 8000 grains (over a pound), with a picric acid charge of 1093 grains. Specimens of both these designs were also charged with gun-cotton, ranging in weight from 656 grains to 1312 grains. In the drop tests, perfect detonation was secured from the gun-cotton charges, even when dropped but three feet. In no case did the picric acid detonate. Grenades charged with both kinds of explosives were then thrown by hand to distances varying from 40 to 65 feet, but in the majority of cases there was failure to detonate.

The unsatisfactory character of the fragmentation of the types just described led to the construction of another design on similar lines. The principal difference lay in the construction of the bodies; but after careful test they exhibited the same lack of good fragmentation, steadiness of flight and consequent failures to explode, small limits of danger zone and the uncertain control of distance and direction. Most of these undesirable qualities are common to all hand thrown grenades. With the exception of the character of fragmentation the action of old style grenades made by us for use in the Civil War was curiously similar. (See Plate I.) These grenades, varying in weight from 1 lb. to 5½ lbs., were furnished with feather-like tails to secure steadiness in flight and were charged with black powder. These were extremely simple in design, as shown by the photograph, and quite ineffective.

In the meantime the destructive effects of the mortar grenade used by the Russians by which the heads of the Japanese saps were demolished time and again and their working parties annihilated, had attracted attention and roused ordnance experts to the fever

of invention. It is a noticeable fact that new developments in war material are so jealously watched by the Powers that any advance by one must be equalled or surpassed by all others. Each seems to be guided by the Darius Green query: "If birds can fly, then why can't I?"

As stated previously, both Russian and Japanese endeavored to overcome the small size and limited range of the hand grenade by the construction of mortars of simple design. This suggestion was taken up by our government, the purpose being to design a light gun and carriage capable of being easily transported and implaced by hand power and at the same time project a comparatively heavy projectile filled with high explosive to considerable distances.

As a basis for disclosing the essential features in such a weapon, quite extensive experimentation was conducted, using for the purpose a light, smooth-bore gun and a projectile whose design followed in general that of the Russian mortar grenade given in the note (p. 28). With a 2-oz. charge of smokeless powder this projectile, weighing 20 lbs., was thrown a maximum distance of 640 yards, with a gun elevation of 45°. The result of the experiments with this rather crude and ineffective equipment was a recommendation to proceed with the construction of a gun, carriage and projectile embodying the general features of this experimental material.

The ends sought by the introduction of the mortar were: to secure a more powerful detonation by means of a large charge of explosive; to obtain greater accuracy in direction and steadiness in flight; and finally to assure longer and more uniform ranges. These were the qualities essentially lacking in the hand grenade up to this time, and it was hoped that the accomplishment of these purposes would cover effectively that part of a defensive terrain beyond the reach of the hand grenade and within the lower zone of howitzer fire. By this link in the chain of fire the entire advance of a besieging enemy from the distant point of his assembly to the very crest of the defensive works and even including his saps would be made painful and distressing.

Drawn from the teachings of Port Arthur, Russian opinion is now positive that it is indispensable to mount in fortifications pieces capable of firing with precision at ranges varying from 50 to 900 yards, and throwing at these distances grenades containing at least thirteen pounds of high explosive.

Late in 1907 our attention was called to the excellence of an English hand grenade and a number of these were purchased and

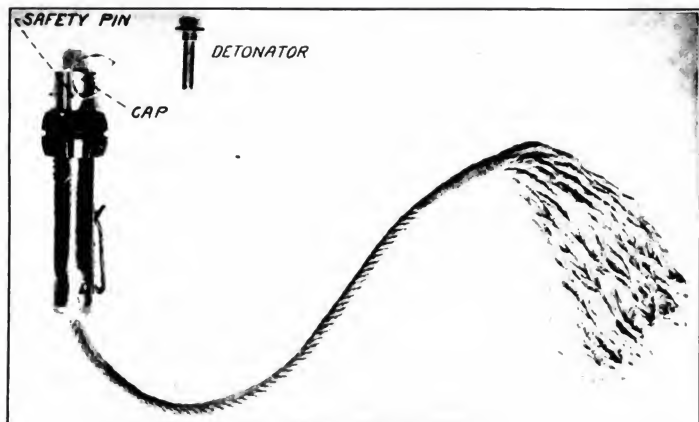


Plate V. The Hale hand grenade.

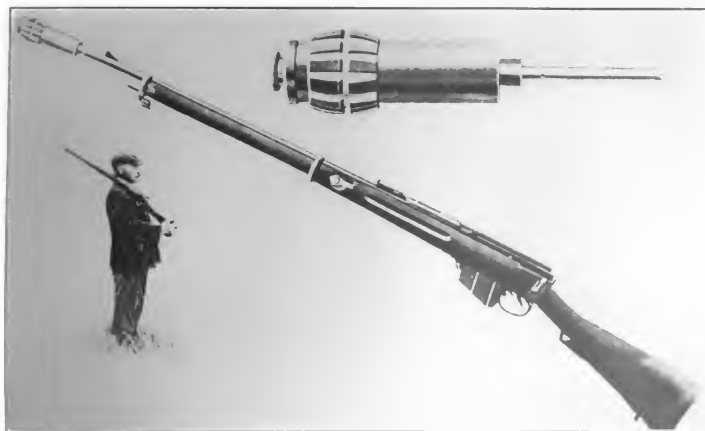


Plate VI. The Hale shrapnel rifle grenade.



Plate VII. Asen hand shell, 1907.

subjected to very complete tests. This, the Hale hand grenade, consists of a brass tube, about 7 inches long, to which is riveted a heavy iron collar, cannellured for fragmentation. At the front end is a sliding cap to which the detonator is secured. The opposite end is closed by a wooden plug attached to which is a rope with an unraveled end, intended for the double purpose of a means of throwing the grenade and to give steadiness in flight. The charge was about 135 grains of tonite and a detonator of the usual fulminate composition. This grenade, like all of the hand type, has inherent faults in spite of the excellent workmanship and its successful response to the tests to which it was subjected.

At almost the same time two independent inventors, one in England and one in this country, hit upon the same idea—a decided improvement in the hand grenade as above described as to its means of propulsion. Both proposed to propel a grenade, of power equal to those already developed, from the rifle of the infantry soldier. The first steps in all new designs are usually tentative, as happened in this case. This construction had the elaborateness characteristic of the first flush of inventive activity. But in it we see the beginnings of a solution to the problem. Here are wings to insure steadiness in flight, a cap to provide safety in handling and transportation, a detachable detonator, and finally a lever and spring so designed as to prevent arming until the grenade had started in flight. The action of this grenade in air was exceedingly clean and arrow-like and was a success in every essential particular.

In the next stage of this development the following requirements were sought:

1. The discharge of the grenade from the gun without danger to the firer or the weapon.
2. Safety in transportation and handling by men in the excitement of battle.
3. Means of varying the range, inherent in the grenade itself.
4. An ease and simplicity of employment to cause the least possible mental concentration of the user.

To secure this first requirement the propelling charge had to be of a weight and energy to give a satisfactory range to the grenade without developing an undue pressure in any part of the barrel. This might appear to be solved easily by the use of a special cartridge containing a small charge of black powder. Experiments, however, showed that although the pressure at the bottom of the bore was quite small yet there occurred so great an accumulation of gas pressure against the base of the stem of the

grenade, resting within the barrel, that deformation took place, rendering the musket useless. This serious obstacle had to be overcome in order to leave the soldier with a weapon whose accuracy as a bullet firer had not been impaired. A charge of small arms smokeless powder accomplished this and is now used.

To fulfil the second requirement, the positive locking of the firing plunger until the projectile was out of the musket was necessary, together with a removable detonator, easily inserted at the moment for firing.

The purpose of the third requirement was to remove from the initiative of the soldier the necessity of varying the range by the manipulation of his musket, no reliance for accuracy being left to his coolness and judgment. It ought to be possible to so instruct men to fire grenades from weapons held at approximately the same angle, provided it was convenient and natural; whereas it might prove extremely difficult to cause them, in the heat of a close struggle, to change the area of impacts by estimated changes in the position of their weapons. This consideration created the application of a device which altered the range from shot to shot if necessary, without disturbing the angle at which the soldier was trained to hold his musket.

The inventors tried to bear in mind the proneness of men under fire to forget or neglect their peace-time training, and every effort was made to avoid multiplying the movements needed in loading and discharging the grenades; and by reducing to the least possible the amount of concentration of attention in preparing the grenades for use. The weakness most to be dreaded in this design is the use of a special cartridge, which is placed in the gun in the ordinary way. No remedy for this has been suggested and must remain a necessary evil so long as the principles in the present construction are retained.

The design of grenade now being considered by our government attempts to secure all the advantages outlined above, and each step in its development is making it nearer a perfect weapon than any importations, so far as known. Each test has disclosed faults whose corrections are zealously sought; and it is the final hope that we will very soon have a grenade as deadly and destructive as the most progressive and enlightened war establishment can possibly desire.



A French Grenadier of the 18th Century.

*image
not
available*

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MINE COMMANDER'S BOARD

BY CAPTAIN L. S. RYAN, COAST ARTILLERY CORPS.

The commanding officer of a gun or mortar battery may, if he keeps a careful record of the data used in plotting and firing a simulated shot, determine with considerable accuracy the probability of that shot being a hit. A mine commander has no means, at present, of checking the work done in his casemate and therefore has no means of knowing how near to the target a simulated mine was fired. If a shot from a gun misses, there will be several other chances for the gun to hit, but a mine that misses, not only never has another chance, but may open a clear channel for the enemy. It will be seen that it is much more important that accurate work be done in a mine command than at a gun battery, and this accuracy can only be obtained by checking the drill daily.

The Mine Commander's Board was devised to furnish this means of checking each step of the operation of firing a mine by judgment, or contact, fire.

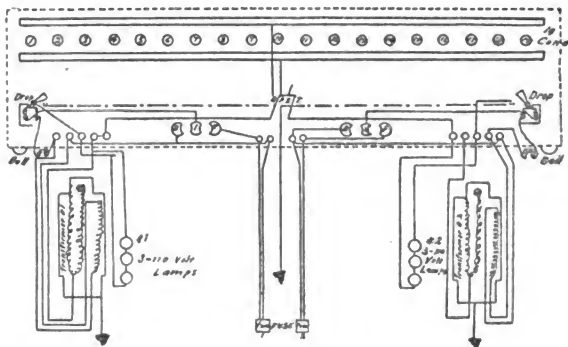
CONSTRUCTION OF BOARD

This board was constructed from the parts of the old pattern operating board for the seven group mine field. A piece of fibre was used as the base on which to construct the board. (Fibre is not recommended as it warps.)

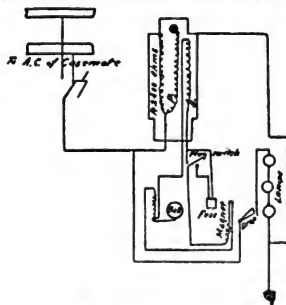
Nineteen terminal plugs were arranged in line and had connections down the back to terminal contacts so that a single conductor from a nineteen conductor mine cable could be attached to each plug. Two bus bars were placed, one on either side of these plugs, and a hole drilled, so as to cut partly into a plug and partly into the bar, thus forming a seat into which a plug switch could be put, to complete electrical contact. The conductor, attached to number 1 plug on this board, connected to number 1 terminal stud on an operating board in the casemate, and number 2 conductor to number 2 terminal, etc. Thus each mine switch on this board was connected to the Mine Commander's Board.

A D.P.S.T. switch below the bars was connected so that each

side was connected to the primary winding of a mine transformer, there being two such transformers placed in the mine primary station with this board. These transformers were placed on trunnions so that they could be easily tipped to allow the ball to roll out of its seat. The case of the transformer was grounded. This D.P.S.T. switch, when open, cut the transformer out from any circuit from the casemate.



Connections to Mine Commander's Board thru Transformer



Mine Commander's Board.

In the secondary circuit of the mine transformer was connected a magnet made of one of the drops of the old style operating board and so wired that the drop would be in the primary circuit after it had fallen. A common vibrating bell was also in series with this winding. Three plug terminals were provided as B, 1,

F, (see diagram) so wired that plug switch between B and 1 made the circuit through the bell magnet and secondary winding. A plug switch between 1 and F connected in series with the bell, magnet and secondary winding, a fuse that was placed outside the mine command station is a heavy box. It was found later that the keeper of the magnet buzzed loud enough so that the bell could be omitted.

The operation of the board was as follows: A plug switch being inserted between the lower bus and number 1 plug, the D.P.S.T. switch being closed and a plug switch between B and 1, when direct current was on the line and a transformer tipped, the automatic switch on the operating board (No. 1 switch) would drop. The transformers being upright and alternating current put through this board, as in firing a mine, the drop on the right of the board would go down, due to the induced current in the secondary winding operating the magnet, and the bell would ring. In the later type the keeper buzzed. In series with this circuit through the drop of the magnet were placed three white lamps, 16 c.p., 110 volt, as it was found that the current encountered too little resistance in this path and the white lamp burned too bright on the operating board. The number of lamps needed are easily determined by experiment.

It will be seen that the operation after firing a mine was duplicated on this board. In other words in place of the transformer being blown off, the circuit was made through a shunt path to earth.

USE OF BOARD

This board was installed in the mine commander's station convenient to his instrument for the observation of fire,—which in this station was an azimuth instrument that was kept oriented with the primary instrument in the same room.

During the drill the mine commander can hear the group and mine designated by the chief plotter. He may have the door open to the plotting room, if in the same building, or use the handset switch. As the mine commander's board is connected to but one operating panel, the chief plotter will have to order this group each time. In this mine commander's station a rubber stamp, made to scale of the plotting board, with 19 mines marked by that number of dots is used and when a track of a target is secured the mine field is stamped in front of the target at convenient distance for plotting. This may be repeated several times for the same target.

The mine to be prepared for firing, being designated by the chief plotter, for example, number 8, the mine commander or his assistant plugs between number 8 terminal and either bus and between B and 1 or 1 and F and follows the target with the cross wire of his instrument until the bell rings (or the fuse explodes depending on which the board was set for). He then records the azimuth of instrument at time of fire. This is kept for checking up after drill.

Should the casemate electrician attempt to fire the wrong mine, there will be no bell rung or fuse fired at the mine commander's station.

Should it be desired, the chief plotter may be required to call off the azimuth of the mine that is to be fired and the azimuth instrument be set to that.

If orders have been issued not to fire mines by contact, the alertness of the casemate detachment may be tested, by putting a plug switch between the opposite bus from that used to connect to mine that is to be fired, and any other plug than that for mine to be fired. A reasonable time before the command to fire should be given, tip the transformer that is attached to the last plug. This will cause its switch in casemate to drop and, unless it is put up, or mine switch opened, both bells will ring when the ordered mine is fired, which shows that both mines have been fired.

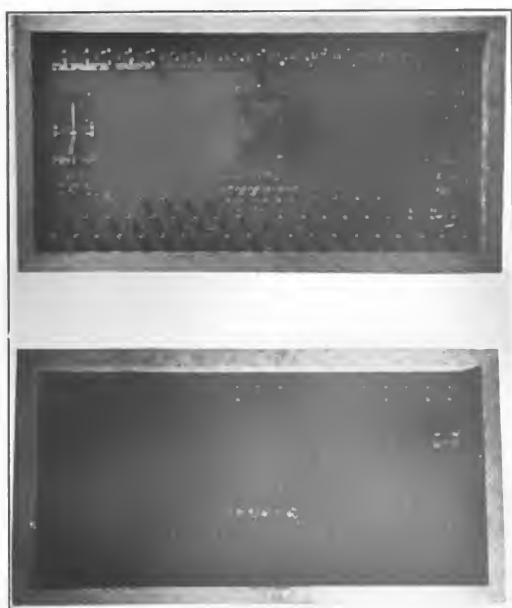
In the absence of orders not to fire when an automatic switch goes down, it is the duty of the detachment to fire the mine whose switch falls. The quickness of the detachment can be tested by tipping a transformer that has been attached to a plug by switch.

After a mine is fired that mine switch should be opened at once. This board will show whether this has been done for the bell will continue to ring as long as alternating current is on, or the lights glow with either current on.

If a fuse is to be inserted the D.P.S.T. switch is opened. This gives protection to the man making connections, for it is then immaterial whether the generator is running or not.

The part on the cut marked "Group" is not described here and is an experimental addition that will be described later, if successful.

The following form is kept at each drill and this record along with the track of the target gives a check on every step in the work. This form is one given by Captain W. R. Vance, U. S. Army, retired, in the JOURNAL, March April, 1909.



No. sheet Date

Manning Detail

Range Officer

Observer at M'	Observer at M''
Reader at M'	Reader at M''
Plotter	Casemate Operator
Assistant to Plotter (No. 1)	Recorder
Assistant to Plotter (No. 2)	

Prediction

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
Travel of target													
Distance to mine													
Number of group													
Number of mine													
Time to mine													
Time complete predict'n													
Az of predicted inters't'n													
Az of target from M. C.													
instrument at fire													
Errors													
In time													
In yards													

By setting the primary and secondary arms to the intersection on each track of the target and taking the second differences between readings, the accuracy of the work of each base end station can be determined.

From this record and the plot of the target, the responsibility for all errors, as well as for accurate work, can be determined. The azimuth instrument can be used to check the readings taken by the primary observer.

Incompetent men were soon weeded out of the range sections and the competent ones learned to work with a surprising degree of accuracy.

It was seldom that any mistake was made in the casemate as to the mine to be fired, the time to fire or the kind of fire.

The value of the training by this system is shown by the mine practice of the 139th Company which used this board. That company recently made two hits out of three, the target being over the mine each time a hit was made and the miss being because it was so dark that the target could not be seen by either observer.

COAST ARTILLERY RESERVES

BY CAPTAIN WILLIAM D. MARROW, C. A. C., N. C. N. G.

Under existing laws and orders, there are three ways by which a National Guard officer can obtain theoretical education and practical instruction in Coast Artillery.

First:—Attendance at the Coast Artillery School, Fort Monroe, Va. (G.O. 203, W.D., 1909.)

Second:—Instruction in the armory at the home stations, and once a year at Joint Army and Militia Coast Defense Exercises.

Third:—Visiting a garrisoned fort and, through courtesies extended by the commanding officer, observing and absorbing what he can by brushing up against the guns, carriages, stations, instruments, apparatus, etc., and by this method gaining information and practical instruction from the officers and non-commissioned officers, with whom he comes in contact, or who are detailed for the purpose of rendering him assistance. (Cir. 28, W.D., 1909.) This practical instruction can be gotten by contact, for seeing and touching vividly impresses the mind, and therefore is more lasting than study from text books. The provisions of these orders and circulars are steps in the right direction and show the disposition of the War Department. It is not many years since such visits would have been laughed at. While these orders and circulars are good, as far as they go, they are not, in my opinion, sufficiently far reaching, or sufficiently flexible, to be of benefit to the majority. To attend the Coast Artillery School, a national guardsman "must be nominated by the Governor of the State, agree to attend and pursue the course of study at the school, be at least 21 years, and not more than 35 years, of age, (though no married officer will be admitted without special authority of the Secretary of War in each case), and stand a physical and mental preliminary examination. He will receive travel allowances, commutation of quarters and subsistence. For subsistence each militia officer will be paid \$1.00 per day *while in actual attendance* at the school. When the school term ends he shall be ordered to his home and all allowances cease, until the beginning of the next term—and will thus continue until the entire course is completed.

He shall be excused from the *practical instruction* which does not take place during the term for theoretical instruction, but *may*, under authority of the Department Commander and, *at his own expense*, take part in the exercises of the troops in other periods of the year."

As at present contemplated, (Report, Chief of Coast Artillery, U. S. A., 1909), the "seaboard states are expected to furnish 902 officers and 21,204 men," this being "one half of a complete manning detail" for Coast Artillery Reserves. With the armory apparatus, which will be issued to each company and the Joint Exercises once a year, the enlisted men are fairly well provided for, in the way of instruction. Their duties are of a routine nature and they can, if of ordinary intelligence, soon learn the duties of their different positions.

As has been said in an address, entitled "Our Coast Defense," delivered to the officers of the Florida state troops, "The different parts of the work are so divided that each man connected with it has his own little part to do, and there is little about each part that cannot be learned and done readily by any man of ordinarily good sense and moderate education."

But what of the officers, especially field and staff? They are expected to be conversant with and well up in all the numerous duties pertaining to the work. Not only Coast Artillery proper, but infantry work, schools of the company, battalion, and regiment, as well as staff duties, for the line officer may be assigned to staff duties and a staff officer to the line. Can we learn these duties from text books, studied at home and aided only by the short practical experience gained at joint exercises and in armories? There is not a doubt, but that, being, "Strong in will to strive, to seek, to find, and not to yield," we have, in the past, and will, in the future, put forth our best endeavors to that end. This has been proved from reports made by regular army officers detailed for that purpose at the Joint Exercises. But it will require a long, long time.

Let us assume, that of the 902 officers, 50 per cent are married. How many of the 451 single officers are able to attend the Coast Artillery School? I venture to assert that not 5 per cent can do so; indeed, not one has attended thus far. But why is this? Because the livelihood of the National Guard officer depends on business. If he is an employe, he must give up his position for ten months for theoretical instruction and procure another situation at the expiration of that time. If fortune favors, he will hold this situation for two months, then resign this for another ten

months at the school. Should he own a business, he would have to leave it to the care of others and the business would go to rack and ruin.

Would the Federal Government permit this from its civil employes or officials? I think not. Then why expect others to do? There are very, very few of us who are so fortunate as to be capitalists, or to have sufficient incomes, to permit us to attend the school, with no thought, or worry, but the school duties. There may be then 5 per cent or 22 officers with incomes sufficient to enable them to become student officers. This leaves 880 who cannot enjoy this privilege.

The Artillery Reserves "have the goods" the Federal Government wants; they are willing, ready and anxious to "deliver them" and have delivered them, as far as they are able, with the help of the theoretical means of instruction at their disposal and the instruction received once a year at the joint exercises. Does the Federal Government need and desire 902 efficient Coast Artillery Reserve officers, or just 22, who may be able to go to the school? The answer is not difficult. But how are the 902 to receive technical and practical instruction?

There may be some who show but little interest in the work and whose only desire is to don the uniform on stated occasions, (this is perhaps the case to a certain extent in all branches of the service) but they are in a very small minority. What of the others, whose interest, willingness, zeal and patriotism lead them to desire to know and learn all that is possible and gain both technical and practical instruction, in any way it can be had, even to the extent of expending their individual funds for such purposes? The interest aroused by what is known as the "Dick Bill", which permeates the National Guard, has brought forth many ideas and suggestions from its officers, for the advancement of both officers and men.

The Illinois National Guard Association have passed a resolution for congressional action, enabling selected officers of the National Guard to serve for one year as Second Lieutenants (Additional) in the regular army, on full pay and allowances, for purposes of instruction and experience. This commission to cease and determine at the expiration of one year, the commission in the National Guard not to be affected thereby.

The Ohio National Guard Association has passed resolutions for congressional action, providing for "the payment to commanders of regiments, battalions and companies, and to adjutants, a sum equal to 30 per cent of the amounts paid to the officers of

the regular army of like rank and service; and to all other officers, 10 per cent of the amount paid to officers of the regular army of like rank and service." Others think the enlisted men should receive one-third of the regular's pay.

This Ohio National Guard Association resolution would be "good business." For it is a well known fact that National Guard officers spend a great deal more than they now receive. Holding a commission in the guard is costly from a monetary standpoint, as well as from the standpoint of the time and labor expended. The regular army wonders why we do it. The answer is, love of country and of the Stars and Stripes, patriotism.

Should such laws as suggested be passed, they would be but further argument, for officers, especially, to be efficient and give value received. They would be most excellent, if they could be made sufficiently flexible and without too many restrictions as to age limit, marriage, etc., so as not to debar the majority, but enable more officers to gain practical, and perhaps along with it, some theoretical, experience. Yet even with such laws in effect, especially for the Second Lieutenants (Additional), the majority of Coast Artillery Reserve officers would no doubt be unable to take advantage of them, as they would either have to leave their business or resign their positions for a year. In my opinion the majority could receive both technical and practical experience, in Coast Artillery, and Infantry work, as follows:

First: By a correspondence course from the Coast Artillery School. Have the commanding officer of each Reserve Coast Artillery Corps, or separate company, or an officer detailed as instructor of the corps or company, take the same course as pursued by the student officers at the Coast Artillery School. When the papers of instruction are received, copy and send them to each of the officers of his corps or company. Have them returned and send the whole to the school for remarks and criticisms. Give certificates of proficiency and file schedules of work accomplished. For cause of any nature, let this privilege be withdrawn and report made of same to the War Department and state authorities for action. This would require but little time on the part of the school instructors, or an officer detailed for this purpose at the post. And about two to four hours per week of the Reserve Artillery officers' time.

Lest some one say: "Impossible! It can not be done! How can the course in High Explosives or the Advanced Course be studied by correspondence!" I hasten to add: These branches, while of great importance, are technical to a great extent. We

do not so greatly need them. The theoretical instruction in the course in Artillery and Gun Defense we do need, to be at all efficient. This *can* be accomplished by *correspondence*, perhaps not in minute detail, but sufficiently to give the student a much greater knowledge than he could otherwise gain. Then the practical experience gained at the Joint Exercises would mean something to us. We would understand our duties, know the whys and wherefores of Coast Artillery and I venture to say the interest would be increased one hundred per cent. Then, too, the enlisted men would realize that their officers knew what they were about, and not have the idea, that I have sometimes heard expressed "We are doing all the work, the officers don't know what to do; they know nothing about their duties, or the apparatus." Show me the officer, who is interested and knows his duties and I'll show you a hard working, contented and interested company. If the officers are not interested and don't know their duties, or the enlisted men have the idea that they do not, then the company will do but little work and perform its duties in a perfunctory manner. In consequence there will be no *team work*.

I was much impressed by the following remarks from a regular army officer, "I never censure the enlisted men of a company for not knowing. If they do not know, the fault lies in the officers' not knowing and not making the men come up to the scratch." If an officer "cannot toe the mark," how can the men be expected to come up to the scratch?

Second: By a law, general order or circular allowing National Guard officers, "when convenient to them," to visit garrisoned forts and volunteer their services for purposes of instruction and giving post commanders authority to place them actually on duty, subject to Regulations and Orders, as assistants to company commanders and staff officers, for any and all duties relating to batteries of gun, or mortars, to mines, or to company administration, etc.—in fact, acting as if they were actually assigned for duty. Under these conditions they, of course, could not assume any responsibilities, or sign official papers, but, while gaining information and instruction beneficial to them, they would at the same time perform duties that would aid the regular officers, who would be willing to have such assistance and be glad to assume all responsibilities.

National Guard officers, as a rule, are sadly deficient in knowledge of ceremonies and military courtesies and especially in paper work, and we are not ashamed to acknowledge our shortcomings. "There are a great many duties to be attended to

between reveille and taps, and the 'military point of view' would soon be thoroughly ground in", as one captain (regular) expressed it, when asked about the Second Additional Lieutenant suggestion: "*Of course* I would be glad to get a live and energetic National Guard officer; and if he wasn't energetic he would soon learn to be." I have heard the same ideas expressed by many army officers, "even if they could have us but for short periods at a time."

By this method we not only become conversant with our duties, artillery and otherwise, but render assistance to officers, who, many without lieutenants, need such assistance and would be glad of the opportunity thus afforded to coach the Artillery Reserve officers.

If the visiting National Guard officer could remain but a week or ten days at a time, it would be that much gained and by repeated visits and "touching elbows" with the regular officers, learn more, even in a week, than he could possibly learn in seven weeks at home. In fact, each *day* spent at a garrisoned fort would be worth one hundred per cent. more than each *week* at home.

The question then arises, would the National Guard officer take advantage of this opportunity? I am sure he would. There are multitude waiting for the way to be opened, that they may grasp the opportunity? We want to do something. We want to prove what we can do and to learn more than we can under existing conditions, even to the extent of going into the "pockets of our jeans" for the funds for such purposes.

As the Federal Government desires that we become efficient in Coast Artillery work, it does seem, with so much to gain and nothing to lose, that the way should be broadened, for a closer affiliation of National Guard and regulars. Then, when the probationary period of the National Guard ceases and we become the 2nd line of defense, a National Guard in reality, the affiliation would be so cemented that we would be almost an integral part of the army. And when in reality we do become the National Guard, may the name Militia be relegated to the 3rd, 4th or 5th line of defense, for then we are Militia no more,—a name which has been handed down in derision, laughter and tin soldiering.

When visiting garrisoned posts, for purposes of instruction, we could be allowed quarters—that is, a room in a casemate, company barrack or any building, that could be made comfortable by the use of such articles as could be procured at the post on memorandum receipt, or with our camp outfits, and if there is

an officers' mess, we could be invited into it, as we doubtless would be, and in the absence of this we could mess with a company. By intercourse with the officers we would gain much, for they are ever ready to discuss, explain and solve any problem of the work. Should a law be passed to pay the National Guard a percentage of the regular pay, we could show our interest by using it for more frequent visits for purposes of instruction. But should neither be done, then open a way by which we can visit forts at our own expense and *perform* duties and not *observe*, for the performance of duties results in much more lasting good. All new methods, schemes, plans and apparatus have a "try out" in Coast Artillery. Why not try the experiment of a correspondence course and actual duty, with one or two Artillery Reserve officers? From the experiment, the War Department could get a line on the results, for future plans.

"If 'twere done, when 'tis done, then 'twere well 'twere done quickly".

This article is not intended in any way as a criticism of means, or methods, as they now exist, but with the hope of more benefits for the Coast Artillery Reserves. And if any word, or thought, herein expressed shall make for the advancement of them, or other arms of the service, it will not have been written in vain. Nor is it written from a theoretical point of view. The desire has been created for more experience, after many talks with regular officers and the first encampment with my Corps at Fort Caswell, N. C., last summer. The desire to try the experiment, per Circular No. 23, series of 1909, W. D., became so strong that I determined to satisfy it.

To that end the following schedule was adopted:—

SCHEDULE

To be absorbed by contact and practical study

<i>Stations</i>	Azimuth and Range Finding Instruments	Examine all parts.		
	Self-contained D. P. F.	"	"	"
	Plotting Board	"	"	"
	Range Board	"	"	"
	Deflection Board	"	"	"
	Atmosphere Board	"	"	"
<i>Guns and Carriages</i>	Telescopic Sight	"	"	"
	Nomenclature	Examine each part.		
	Gun Sights and Sighting	"	"	"
	Powders, Projectiles, Primers, Fuzes	"	"	"
	Service of the Piece	"	"	"
	Aiming and Laying	"	"	"

<i>Mortars</i>	{ Same as Guns Quadrant	Examine each part
		" " "
<i>Mines</i>	{ Rapid-fire Guns and Carriages	" " "
	{ System	" " "
	{ Loading Room	" " "
	{ Casemate	" " "
	{ Station	" " "
<i>Artillery Engineering</i>	{ Cables	Examine all parts.
	{ Aeroscopes	" " "
	{ Telephones	" " "
	{ T. I. Clocks, Bells and Interrupters	" " "
	{ Wireless System	" " "
	{ Meteorological Instruments	" " "
	{ Searchlights and Accessories	" " "
	{ Dynamos, Motors, Etc.	" " "
	{ Controllers	" " "

Go Out on Tug—Range Rakes, etc.

Volunteer services for anything and everything, do what ordered to do and do it with a will, however small it may be. Coast Artillery is made up of small things. Above and beyond all: Don't listen, should you be told by anyone, either officer or enlisted man, that it is immaterial or does not matter. *It is material and it does matter.* This was learned from experience, after being told otherwise. The *small thing* is of much importance and very, very interesting, when understood. Ask questions and then continue asking questions.

This was not adopted with the idea that the whole could be learned in the short time I could spend at a fort, but merely as a guide and for some system.

Artillery Engineering was placed last, as I was more conversant with this branch than with the preceding.

I was given the following letter:

STATE OF NORTH CAROLINA
OFFICE OF THE ADJUTANT GENERAL,

Raleigh, June 26, 1909.

To the Commanding Officer, Fortress Monroe, Va.

Sir:—

On his own request, Captain Marrow, Coast Artillery Corps of North Carolina, is permitted to visit Fortress Monroe for the purpose of instruction and to continue a course of study he is following, relating to Coast Artillery. Any courtesy or information to this end that you may see fit to give Captain Marrow, will be appreciated.

Very respectfully,

(Signed) J. F. ARMFIELD,

Adjutant General.

I proceeded to Fort Monroe, Va., August 3, 1909, for Tcur Number One, if I may so call it, presented the letter to the Commanding Officer, and received the following order:—

OFFICE OF THE COMMANDING OFFICER.

Fort Monroe, Va.

August 3, 1909.

Commanding officers of batteries and noncommissioned officers in charge of power and lighting plants will accord the bearer, Captain W. Drummond Marrow, North Carolina National Guard, every facility for inspection of armament, position finding service, power, light and communications.

By order of Lieutenant-Colonel Townsley:

(Signed) J. F. Howell,
Captain, Coast Artillery Corps,
Adjutant.

Every courtesy and facility was extended by the officers, noncommissioned officers and privates, without an exception, and from this date until the 18th of August, I was kept busy. A synopsis of Tour No. 1 follows:—

I examined and manipulated the instruments in range finding stations and plotting rooms, studied the guns, carriages, service of the piece, aiming and laying, sights, powders, projectiles, primers, fuzes and endeavored to learn the general duties at the batteries. Was with the battery commander of Battery Parrott, 12-inch guns, in B.C. station, plotting room and emplacements at every drill during this tour, with the exception of two forenoons on tug, one forenoon at Battery Bomford, 10-inch guns, observing calibration of the piece and sub-caliber practice, one forenoon at Battery Ruggles, 12-inch mortars, observing sub-caliber practice, and two forenoons, observing service practice of two visiting Coast Artillery Companies from Fort Washington, Md.

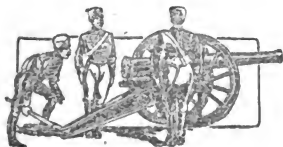
Then again it was my pleasure to be present and in camp during the Joint Army and Militia Coast Defense Exercises, September 13 to 26, 1909, in the Artillery District of Chesapeake Bay, which is Tour No. 2; the following is a synopsis of this tour:—

From September 14 to 26 my time was fully occupied from reveille at 5:40 A.M. to tattoo at 9:00 P.M. and often until taps, 11:00 P.M., discussing some question, or having some problem explained by a regular officer. During this period, was with the battery commander at Battery Parrott, at morning, afternoon and night drills, observing, studying and absorbing things pertaining to battery commander's duties, messages from fire commander's station, readings from and messages to B' and B" and plotting room, artillery drills, etc.

Assisted the district artillery engineer, attended evening lectures, inspected battery, test of observers and gun pointers in position finding service; inspected quarters; observed drill of mine

companies; subcaliber and service practice of the Coast Artillery Reserves of Virginia; call to arms and land attack; witnessed mine practice, night attack, land and sea. Examined and manipulated the self-contained horizontal base R.F. instruments.

These two tours, especially the 2nd, were most pleasant, profitable and busy experiences and without an exception every officer with whom I came in contact, extended courtesies and rendered any assistance requested; indeed, the services rendered, assistance and information given, interest shown, courtesies extended, time expended for explanations, problems solved and discussions of subjects were of inestimable benefit and the tours were of more benefit in acquiring information of practical Coast Artillery work, than study from text books could not have given in a year. With this experience, technical study is now clearer and I can better appreciate and absorb such material than formerly. This experience is not exceptional, others can and will receive like treatment at such visits, not only to Fort Monroe, but to any coast fort. It has been my privilege to be thrown with many Coast Artillery officers from different posts and they are ready and willing to render any assistance in their power and take special pains where interest is manifested.



PROFESSIONAL NOTES

FRENCH COMMENT ON THE SHELL QUESTION

It will be recalled that after the explosion on the French battleship *Jena* while in dry dock at Toulon, she was repaired sufficiently to serve as a useful target. Enough of her interior fittings were also installed, to enable an estimate to be made of the destructive effect of shells bursting inside.

The program of the tests was drawn up in the summer of 1908 and the first firings took place in August, 1909. One of the distinct objects sought in the tests was to determine the value of the proposed new shell, of 968 pounds, for the 12-inch guns of the *Danton* class of battleships; but of course the occasion was used to decide many other important questions as to the effect of gun fire.

The most interesting and perhaps the most important point which these trials bring up is the value of thin-walled shells carrying a large charge of explosive and bursting outside the ship, as compared to the effect of thick-walled shells containing a small charge which is or may be carried through the armor and exploded on the inside.

The official results of these firings have not been, and probably will not be, given to the public, but the question is one of such intense interest to the military world that naval journals such as *Le Yacht* and the *Moniteur de la Flotte*, have published articles describing a part of the tests and drawing most interesting conclusions from them. The *Revue de Paris* for September 15, 1909, also comments at length on the relative value of armor-piercing shell and torpedo shell. Translations of these articles will be found below.

The authors of the articles in the *Revue de Paris* and in the *Moniteur de la Flotte* apparently represent the prevalent opinion of line officers of the French navy, in favor of a shell carrying a heavier charge of explosive (melinite) in proportion to its weight than does the new 12-inch shell of increased weight used in the *Jena* experiments. The weight of the bursting charge for the new shell is believed to be 29 pounds, or 3% of the total weight.* The weight of melinite for the regular 12-inch shell, the one now in general use aboard French ships, is 18.7 pounds. The first shell weighs 968 pounds, the second, 750 pounds. It would seem evident, also, from the articles above referred to, that the French have as yet no satisfactory fuze for high-explosive shell.

The article from *Le Yacht* apparently represents the prevalent opinion of the Ordnance Corps of the French Navy concerning the relative values of torpedo shell and small-charge-carried-through shell. These officers do not believe in the value of large charges bursting outside the armor but insist on the need of carrying through and bursting behind the armor the largest charge which can be put through. Evidently the Ordnance Department considers that the line of the French navy has been unduly influenced by the reported

* The greater weight given in the article from *Le Yacht* is probably incorrect.

moral and material effect of the Japanese shimose shell in the battle of Tsu-Shima—shells which carried at least 10% of explosive. They believe that such shell cannot be fired with as high velocities as ordinary shell and that penetration is sacrificed. Apparently the maximum muzzle velocity which the French have found it possible to use with shell carrying a large quantity of high explosive is about 1950 f.s. The muzzle velocities used in the *Jena* experiments correspond to ranges of 6000 to 6500 yards.

The statement made in the article from *Le Yacht* that the coast batteries are provided with "P" shell* and with no others, may be doubted, as it is thought that armor-piercing shell from previous stock are still on hand.

Following the translations above referred to will be found the translation of an extract from a Russian author in which considerable attention is given to the same shell question.

The following English equivalents of French terms should be noted in reading French articles on this subject.

"Obus de rupture." The equivalent of armor-piercing shot (U. S.). A shell with walls thick enough to penetrate the heaviest armor and carrying a small charge of explosive, from 2½% to 3% by weight.

"Obus de semi-rupture." The equivalent of armor-piercing shell (U. S.), the explosive charge being from 5% to 6%.

"Obus torpille." Torpedo shell. A shell carrying a very high per cent of explosive, say 20%.

"Obus alourdi." A shell heavier than the one originally designed for the gun and carrying a greater weight of explosive.—EDITOR.

ARMOR-PIERCING SHELL AND TORPEDO SHELL

The projectile question is one which is engrossing the attention of all naval powers. For the land service the problem was relatively simple and it has been definitely settled; for the naval service it was and remains much more difficult; at the present time no power can boast of having reached a solution which will guarantee a positive superiority in a naval engagement. In foreign countries, particularly, researches are continuing with the greatest activity; the ideas which resulted in the present projectile, *i.e.*, the armor-piercing shell capable of penetrating battleship armor, are being willingly abandoned and ordnance officers are seeking to increase the bursting charge as far as possible. This tendency has been emphasized since the battle of Tsu-Shima, and especially since the publication of the first note book of Captain Semenoff, attached to the staff of Admiral Rodjesvetski, and its translation into French under the title, "The Death Struggles of a Battleship."

In France, our naval ordnance officers, who, twenty years ago were the most ardent and enthusiastic advocates of the high explosive shell, follow the present movement with regret. Their efforts and their work have resulted in giving us a cast iron shell, loaded with melinite, which, having no longer sufficient strength to be fired without danger from existing guns, is therefore obsolete and should serve only as a starting point for further investigations. But our ordnance officers and experts have not been willing to follow this course; for more than ten years their studies have dealt principally with armor-piercing projectiles. The experience of the Russo-Japanese war has not modified their ideas; it would appear, on the contrary, to have confirmed their

* See page 50, Armor Piercing Shell and Torpedo Shell, from *La Revue de Paris*.

belief in the importance of armor penetration; they entered the gun versus armor struggle on the side of the gun and there they insist on remaining. The superiority of the gun over the armor plate is demonstrated definitely by proving ground trials; the maintenance of this superiority is daily becoming more simple since the weight of armor is on the decrease in all navies; the policy is to decrease the defensive and increase the offensive power, by reducing the thickness of the armor and increasing the number and caliber of the guns.

But the gun is only a means; the projectile is what should have been studied first and foremost, not in order that it might be enabled to penetrate victoriously greater and greater thicknesses of steel—that is not the problem—but in order to insure its maximum utilization as an agent of destruction. Other things being equal, the most powerful artillery will always be that which can launch the most deadly projectile. It seems pueril to make such a statement; nevertheless the efforts of inventors and constructors are bent largely towards the perfection of turrets, of guns, and of all accessories, without examining in the first instance the final result which is being sought.

It has been so in all navies. For this, there is one excuse which is also a reason; the first efforts to substitute torpedo shell for armor piercing shell were unfortunate; there were numerous proving ground accidents; the shell often burst in the gun while they failed to burst or burst only partially on impact; moreover the damage due to the explosion on impact was insignificant. The use of such shell on board ship was extremely dangerous, while their manufacture was attended with many difficulties. This sufficiently explains the fact that all navies are at present without a supply of torpedo shell, or at least shell carrying large bursting charges. The French Navy Department, however, has seen the War Department succeed in manufacturing and preparing a shell of great explosive carrying capacity, the famous "P" shell, which is now supplied to all our coast batteries and which has been tested recently against the hull of the *Duperre*.

Battleships and heavy cruisers are protected against armor piercing projectiles by armor belts, which insure safety for a relatively small distance above the water line and a still smaller distance below; the vitals of the ship, below the water line, are also protected by the water itself which causes the ricochet of projectiles now in use. The "P" shell, however, penetrates the water without ricocheting and is therefore able to reach the vitals of a ship below the armor. Present battleships have no protection against such a form of attack. Projectiles of this nature have well been called torpedo shell; they might also be termed shell of great capacity, for they carry a little more than 20% of their weight of high explosive.

Armor piercing projectiles were constructed originally for the sole purpose of making holes at the water line of ships, of dislodging armor plates, of breaking up the armored belt, hence their other name "projectiles de rupture;" it was claimed that at the end of an engagement the armored belts of the ships most injured would be as full of holes as a skimmer and that the ships would sink under the weight of water they had taken in. This idea has not yet disappeared entirely; it survives through the hope that a few kilograms may be added to the present projectile (about 2½% of its weight) and that thereby it may be transformed into a real shell "de rupture." (As yet, this is only a scheme on paper for which the Navy Department will ask five million francs.) When the transformation is completed, it is claimed that our ammunition supply will comprise projectiles which not only can penetrate but also can burst after penetration. These new shell, however, will not burst as planned. They

may do so under very favorable conditions which can be procured easily on the proving ground but which will be presented rarely in actual service. The line officers of the Navy, therefore, recognize these projectiles as penetration agents only, not as explosive agents, and for this reason they will protest against the acceptance of the new projectile, as for a long time, although without success, they have protested against the present so-called "projectile de rupture."

But the advocates of the torpedo shell are divided into two almost equal groups, each as ardent as the other in the defense of its preferences. There are those who believe that the shell should contain a relatively small amount of explosive, the walls of the shell being sufficiently strong to insure the penetration of quite thick armor; others contend that the shell should contain a large quantity of explosive, that the walls should be relatively thin, that penetration of thin plates only is necessary, and that the murderous effect on the personnel will be assured by the terrible deflagration of the bursting charge. In other words, there are conservatives who believe in the power of high explosives, but who think it is indispensable that such power be combined with armor penetration—and there are radicals who place small value on penetration and demand all the destructive energy due to a large quantity and the certain effects of high explosive.

In order to satisfy the first of these, our naval ordnance officers have conceived of a shell of small capacity, carrying from 6 to 7% of its weight of high explosive and calculated to burst after penetration. This has been called a semi-rupture shell. It remains to satisfy the second class, those who demand a shell of great capacity, like the "P" shell, that is, carrying from 20% to 25% of its weight of high explosive and calculated to burst at the instant of impact. The problem is far from being insoluble but it has not been solved or even attempted by our naval ordnance officers, who place full confidence in the semi-rupture shell.

Our naval construction department has decided that the bursting charge of black powder of the armor piercing shot (obus de rupture) shall be replaced by a charge of melinite, and they have adopted for use on forthcoming battleships, particularly those of the *Danton* class, a type of extra heavy shell (obus alourdi) which by reason of its greater length will contain more explosive than the present shell provided for battleships of the *Patrie* class.* At this point they have stopped short. Without referring to the difficulties to be encountered in the case of a shell carrying 20% or 25% of its weight as a bursting charge, it may be mentioned that, urged on by the line of the navy, the construction department has recently had under consideration the design of a shell of 10% capacity, and of such material and strength as to permit its being fired from the high-power guns being installed on the new battleships. The cast-iron shell, carrying 10% of its weight of melinite, provided for our fleets twenty years ago, and which gave us then incontestable superiority over other maritime powers, has for ten years been useless.

It is well known that no one has dared to fire a single one of these shell on board of our latest battleships. The despatches, so widely quoted, at the beginning of the Morocco affair, to the effect that Casablanca had been bombarded by the *Gloire*, using melinite shell, were false; only the smallest cruisers like the *Galilee*, the armament of which consists precisely of the low power guns for which the melinite shell were designed, ventured to use them in the

* The present 12-inch (305 mm.) shell weighs 750 lbs., and carries 19 lbs. of melinite. The extra heavy shell will weigh 970 lbs., and will carry 29 lbs. of melinite; it is to be used in the experiments on the *Jena*.

bombardment. Furthermore we are assured that the captain of one of the cruisers took the precaution of reducing the propelling charges so as to diminish the pressure and, consequently, the chances of the bursting of a shell in the bore. The report is entirely credible and such a measure was only prudent, since, at that time, the safety of the "B" powder was in question; it was known that the pressures obtained were often excessive and dangerous to the gun itself. Praise without stint is due to all who shared in those firings, the first that any one had dared to hold on a man of war. The precautions thought necessary by the Coast Artillery last June at the time of the experiments on the *Massena*, with these same cast-iron, melinite filled shell, were quite different: the lots of powder were then carefully selected, the cannoneers were withdrawn from the vicinity of the guns, and the pieces were fired from a distance by electricity.

It can not then be said that our cast-iron melinite shell, which can be utilized solely by old vessels, offers every confidence desirable as to its safety. It is otherwise regarding the steel semi-rupture shell also filled with melinite but with about half the quantity. The latter are designed for use in the highest power guns and have replaced in the ammunition supply of modern battleships, the cast iron melinite shell. They can be used without doubt, but even they are not perfected. In December and January, last, four shell of this kind burst at the proving ground at Gavres; two were 12-inch shell and two were 7.6-inch; one of the 12-inch burst in the bore of the piece.

It is certain that foreign powers are giving great attention to this subject, and it is not less certain that they have succeeded, some time since, in manufacturing shell carrying 10% of their weight of high explosive, comparable or even superior to our cast-iron, melinite shell, and which can be fired from the most modern guns. Indeed at the battle of Tsu-Shima, such shell were used by the Japanese with deadly effect on the Russians; so much so, that many writers do not attempt to show wherein the tactics of Togo were superior to those of Rodjesvenski, but attribute the victory of that day to the famous, large capacity, sensitively fused shell of the Japanese—the "portmanteaux" of "trunks full of explosive" as they were termed by the Russian officers.

Up to the present time, the most ardent advocates of high explosive shell, among our ordnance officers, have aimed only to utilize the guns which they have constructed; the problem which they have set for themselves to solve is the following:

To design a projectile which shall carry the maximum quantity of high explosive, compatible with the power of the present gun, and which shall be able to penetrate thin armor bursting after impact, whatever the obstacle.

This is assuredly a difficult problem and one requiring the study of many details; particularly the study of the mechanism of explosions, followed by complete experimental firings at the proving ground, utilizing guns of all calibers and armor plates of various thicknesses. It is said that our ordnance officers have victoriously solved this problem by the steel, semi-rupture projectile. But the real question was the following:

To construct a gun which should possess sufficient power to hold its own with the present gun, but which should be compatible with the adoption of a projectile carrying a great quantity of high explosive and bursting on impact, whatever the obstacle.

The increase of initial velocities and penetrating power hypnotize the mind; and our ordnance officers have always in view the destruction of turrets and the production of holes at the water line in order to accomplish the anni-

hilation of the ship; they insist that the destructive power of high explosive shell is intimately connected with their penetrating power. This can be demonstrated by proving ground experiments, as far as armor plates are concerned, and we willingly accept their statements on this point; but the question is more complex. It is necessary to calculate the chances of penetration since penetration is the reason for the preference accorded the semi-rupture shell over the torpedo shell. Now the chances of penetration are always very much reduced in time of war; in the equation of the problem, when properly stated, they must be given a very small coefficient. On the other hand, shell of which nothing is required but that they shall burst on impact produce, for every hit, explosions the power of which is a function of the amount of explosive which they carry. They will not inflict extraordinary damage, it is true; the armor belt will protect the lower deck, the engines, the boilers, the magazines, in a word all the vital parts of the ship; but aside from the general though not insignificant damage which they will inflict on the more lightly armored portions of the hull and on the superstructure, they are more able than armor-piercing shell to bring about that crisis which puts the ship at the mercy of the adversary and makes it the defenseless prey of the torpedo boats which have only to approach and deliver the *coup de grace*. The explosion of such shell produces an effect on the nerves of the personnel which deprives them of all power to act. Men untouched by the fragments are incapable of executing the orders they receive or of recovering their self-possession in the intervals between the hail storms of fire. Even in the sheltered depths of the ship, where the noise of the explosions come only as dull thuds, the effects are quite as terrible, for the poisonous gases which have enveloped the main deck are rapidly drawn into the engine and furnace rooms where they slowly kill the occupants. The disorganization of all that gives life to the ship is rapid and complete; its vital parts are intact; it floats; but it is dead. Such, without any exaggeration was the action of the Japanese shell at Tsu-Shima. Captain Semenoff has given the following account of his experience on board the *Souvaroff*, the ship on which the fire of the entire Japanese line was concentrated, since it carried the flag of the Admiral Rodjesvetski:

"It seemed to me that it was no longer ordinary projectiles which struck our sides and fell on our deck, but entire mines, and that these mines exploded wherever they struck. The slightest object in their paths, a hand rail, a funnel stay, a simple rigging rope, caused their instant detonation. The side plates and the superstructure were torn and twisted into shapeless masses the fragments of which mowed down the personnel. Iron stairways were rolled into spirals; guns, unharmed were snatched from their mounts.

"Such carnage could never have been caused by the simple impact of projectiles, still less by their fragments; it could only result from an extraordinarily powerful explosion; the Japanese, apparently, had realized the American idea which placed on the *Vesuvius* the famous dynamite guns.

"But all this would have amounted to little if, in addition, there had not been a fearful rise in temperature and bursts of liquid fire which inundated everything. With my own eyes I saw a sheaf of sparks gush from a steel plate when it was struck by a shell and if it was not actually fused, all the paint on it was volatilized leaving it perfectly clean.

"Objects difficult to ignite, such as hammocks and rows of filled water buckets, burst instantly into brilliant flames like lighted torches. Even with the aid of smoked glasses nothing could be seen clearly, for the silhouette of

every object was confused and distorted by the vibrations of this infernal atmosphere."*

The narrator adds: "It was not like this on the tenth of August." He had been on board the *Tsarevitch* in the battle of that date, when the two adversaries used only armor piercing projectiles, or at least shell with small bursting charges, and he regarded it as target practice rather than a battle.

An American named Gathman invented, some years since, a formidable aerial torpedo weighing 1830 lbs. and carrying 705 pounds of explosive. The shell was designed to be fired from an 18-inch gun. For purposes of comparison, we will remark that the charge of a submarine torpedo of the same diameter is only 220 pounds and that the charge of a semi-rupture shell of 18-inch caliber would not exceed 77 pounds. According to the official report the mechanical results of the Gathman shell were inconsiderable.

Further study of shell of large capacity was abandoned, temporarily. But the lessons of Tsu-Shima, by demonstrating the true action of these shell, have incited the various powers to renewed experiments; the French Navy alone seems to lack interest in the subject.

Our naval ordnance officers, in order to force upon the line of the navy the material they believe to be best suited to war, have always cited the failure of the Gathman shell. At the least they should have made comparative studies and experiments which would have served to enlighten the navy at large and permitted it to determine its choice. They have preferred to refrain from so doing. They have accumulated test upon test during long years, only to find that the semi-rupture shell, which conformed most closely to their personal views, was giving entire satisfaction, at least temporarily, to those who demanded high explosive shell. They carefully preserved the shell "de rupture" for use against the thick armor of water-line belts, claiming that in actual service those projectiles would wreak frightful havoc. The battle of Tsu-Shima suggests this remark for their benefit: *penetration by shell "de rupture" was generally ineffectual.*

There are excellent chances that this will always be the case in naval combat, because too many conditions must be fulfilled to insure penetration and especially because these conditions are difficult to realize. Nevertheless in the artillery course of *l'Ecole Supérieure de Marine*, it is always a question of penetration; it is said, for example, that "if the lengthening of projectiles is advantageous for any other reason"—lengthening is the only means of increasing the bursting charge for a given caliber—"it is disadvantageous from the penetration standpoint"; and again, "the present ammunition supply should comprise only shell 'de rupture' and shell 'de semi-rupture'; but it would be advantageous to replace both by a projectile like the present shell 'de rupture' with a greater bursting charge because the projectile 'de rupture' has a greater effect on armor."

Such illustrations from this course might be multiplied to show this craving for perforation; its consequences are incalculable; disturbing today, they augur worse for the future, on account of the rapid progress in maritime material, the enormous outlay involved in any change of supplies, and, most serious of all, the time necessary for manufacture.

The possibility of such favorable experimental firings as is presented in the case of the *Jena*, ought to have impelled our naval Ordnance Department to reopen experiments with melinite shell, starting with the steel shell of 10%

* "The Death Struggles of a Battleship," translation of note-book of Captain Semenoff for the Commandant of Balincourt.

capacity and increasing the bursting charge up to 20% or 25% of the weight. There was plenty of time for the manufacture of the necessary projectiles, which if they were to be convincing, should have been complete. It was well known that the experiments were to take place, there was talk of using a lot of shell of large capacity made for the battleships of the *Danton* class; it was even said that if the General Staff had ordered only a part of the supply of those ships to be of the semi-rupture shell, it was because they were awaiting the results of these experiments in order to determine the character of the remainder. As a matter of fact, there have been provided, for the firings on the *Jena*, only shell of 10% capacity and these solely for the 6.3-inch gun. In addition, the Ordnance Department took hardly the time to prepare a scheme for the firings, worked out with sufficient care to warrant the acceptance of the results without the greatest circumspection. It appears that the main object will be to confirm and supplement the Gavre proving ground tests concerning the present regulation projectile or others little different therefrom. This was not enough; that target, (the *Jena*) which had cost us so many human lives, and for the preparation of which no small amount had been expended—that target which it will be impossible to replace—should have been utilized primarily or even solely for the purpose of settling the question of the use of shell carrying large bursting charges of high explosive, which is without doubt the most important question of modern artillery.

The *Duperre*, at least, did not sink without furnishing the War Department valuable indications concerning the "P" shell, or without putting an end to the controversies and uncertainties which were disturbing the service. For there are in France two camps which are directly opposed to each other on the shell question: on one side is the War Department, on the other the Navy Department. The former has adopted for the coast defenses a shell of large capacity and places in this shell the utmost confidence, since its value has been proven; the latter, on the contrary, has faith only in armor piercing shell carrying a small bursting charge. Where lies the truth? Once more is not the battle of Tsu-Shima an answer in this uncertainty? Here are the conclusions drawn from that battle by Captain Semenov:

"The first school (those advocating the small capacity shell) believe in a heavy projectile with walls thick enough to secure armor penetration; the capacity is thus diminished and little explosive can be carried; delay action fuses must be used so that the projectile will not burst until it has reached the interior of the target. According to the advocates of the second theory, the thickness of the shell wall should be just sufficient to prevent the premature bursting of the shell; the result is a large increase in the bursting charge; the fuses are made and set so that they will detonate on impact against the slightest obstruction.

"The first of the theories is English, the second French. In the last war we had adopted the first method of shell construction while the Japanese had adopted the second."

If the line officers of our navy had been in control of matters like this, they would have required that the Ordnance Department, in seeking a solution to the problem, undertake the method which we have suggested. This would have involved first, the adoption of a projectile of great capacity for high explosive, and then, the selection of a gun suitable for this projectile. For declining to consider all overtures which were made to them on this subject, the ordnance allege two principal reasons:

- 1st. Flat trajectories improve the chances of hitting

2nd. Flat trajectories are essential to rapid fire-control.

If neither of these reasons were refutable it would be necessary to abandon projectiles of large capacity, since the weakness of their walls prohibits their use in high power guns with high initial velocities and flat trajectories. But the first reason is a simple statement and the second has no great weight in actual practice.

As to the first reason, the Ordnance Department base all their arguments on an increase in the danger space which, evidently, increases with the flatness of the trajectory; they fail to take into account all the causes of error which affect the fire of ship against ship, and these causes are very numerous. The danger space is not an absolute but a relative measure of the chances of hitting. In fact, considering all causes of error, and assuming a rough sea, if the chances of hitting are calculated for two projectiles, one having an initial velocity of 1968 f.s. (600 meters) and the other 2624 f.s. (800 meters) it will be found that:

1st. With good range-finding, the advantage is with the lower velocity for all ranges.

2nd. With indifferent range-finding, the chances are equal at long ranges and are in favor of the lower velocity at mid-ranges and short ranges. Long range is taken at from 6540 to 5450 yards (6000 to 5000 meters), short range as under 3270 yards (3000 meters).

The conditions which we have assumed may be taken as the average conditions of firing at sea; the advantage is, therefore, almost always with the lower velocity.

Let us assume the most efficient range-finding system. In the case of flat trajectories it is not to be denied that the greater the initial velocity the less will be the time of flight and the easier and more rapid will be the fire-control by the observation of the points of fall. Now the rapidity of fire-control will be of considerable importance on the day of battle, since the fleet which is hit first will be in a position of certain inferiority. But the difference in the rapidity of fire-control in the two cases, one with an initial velocity of 1968 f.s. and the other with 2624 f.s. is small, even in target practice where there is nothing to interfere with the observation of the points of fall; on the field of battle the difference would be still less marked.

Why then have not initial velocities of about 1968 f.s. (600 meters) been adopted? They are advantageous from the point of view of hitting; they possess but one inconsiderable disadvantage from the point of view of fire-control; and they alone permit the use of shell of great capacity, such as the "P" shell. Moreover a reform of this nature appears to have advantages affecting a large part of the material. For example, the weight of all guns and accessories would be diminished; their net cost would be diminished; and, for battleships of equal tonnage, the number of guns and their ammunition supply would be increased, or their speed and radius of action. Altogether a complete renovation of our material would result.

Precisely because it would be a revolution has no one dared to undertake it. The ordnance officers of all countries, carried away by their enthusiasm along what they believe to be the path of progress, have built guns of great perfection which are the fruit of deep study and the labor of many years; they do not like to admit that if the projectile of the future is to be a shell of great explosive carrying capacity, their work has, so to speak, gone for naught. Such, however, will be the inevitable result: a new conception of the power of projectiles will banish the high-power rifle, the most marvellous product of modern metallurgy, and we shall turn back to old-fashioned types, even to

those of twenty five years ago. The ideal torpedo shell will be, moreover, one which explodes equally well on striking the superstructure, or the hull below the armor belt. Besides the fact that the target will thus be a maximum, a fortunate hit will be fatal. The War Department expects to secure this result by a modification of the "P" shell. It cannot be denied that the nation which first successfully accomplishes this end and transforms its naval artillery accordingly, will obtain supremacy of the sea. In this respect our navy is the farthest behind; we had the opportunity of taking the lead by profiting by the *Jena* to make complete experiments; the *Jena* will sink without their having been made; it will be too late afterwards to have regrets.

—*La Revue de Paris*, September 15, 1909.

THE FIRING EXPERIMENTS AGAINST THE JENA

The conditions under which the firing is conducted are known. The *Jena* is moored in the harbor of Salins Hyeres. The firing ship is placed broadside on to the *Jena* and at a distance of 550 to 650 yards, and the firing gun is pointed with scrupulous care, so that the projectile shall strike the exact predetermined spot.

The power charge used is not the regulation one for the projectile and caliber, but one that will give it a velocity at the target which it would have if fired at 6000 yards range with normal charge.

The gun is not fired until the predetermined conditions such as angle of the target, complete steadiness and perfect pointing are secured. The shot fired, the Board goes on board to note the effects produced and photograph the parts affected. It will be seen that under such conditions the firing must be extremely slow, hardly more than two shots a day.

Rear Admiral Lebris, who commands the Gunnery School Division and who has made ordnance matters a specialty, is President of the Board conducting the experiments, and it includes besides as members, one commander, three lieutenants, two officers of the Ordnance Corps, (Colonial Artillery officers assigned to the Navy Department), nearly all of whom are attached to the *Tourville* and *Pothuau* (Gunnery School Ships). A medical officer and pharmacist of the Navy are joined to the Board as adjuncts to witness and consider the probable effects of the firing on life (by live animals placed on board, etc.).

The *Conde* began the firing with her 6.4-inch (16 cm.) guns and the *La-touche-Treville* followed with her 7.6-inch (19 cm.) guns. Naturally these medium caliber shells were fired against the thin armor of the casemates and unarmored portions. The effect was considerable, and, in certain respects, surpassed expectation. Thus, common shell containing only 2% of their weight, in explosive, sufficed to start a fire in one casemate and burn the filled powder cases that had been placed there. Some people, in too much of a hurry, have hastily concluded that the practice of accumulating a supply of ammunition about the guns, in advance, in order to meet the rate of fire which is greater than the ammunition hoists can supply, must in future be abandoned. We do not agree with them in such a heedless deduction. We should say, rather that it is essential to thoroughly organize the fire service for battle to quickly stop all fires that may start at any place and also, as we have known already for a long while, to avoid at any cost abuse in the employment of combustible materials: paint, linoleum, etc.

The perforating force of the projectiles in question was well known through previous experiments; there was no surprise in that. But the same may not be said in regard to the asphyxiating effect of the projectiles loaded with explosives. Dogs, rabbits and pigeons were placed in the casemates, turrets and batteries of the *Jena*. They even went so far, in their desire for accurate knowledge, as to fit microphones over the hearts of certain of the animals, in order to observe (apparently by wire), from the firing ship, the physiological effect of the firing on their organism, this was given up very soon, because of the insignificance of the results. But they were not a little astonished to find, in most of the experiments, dogs, pigeons and rabbits quite alive and very well, notwithstanding that shells had burst in their vicinity; and unless struck, or burned by fire, they did not suffer otherwise. Analyses of their blood showed that the dead ones had succumbed to injuries through wounds received, and not from being poisoned by the gases. This is in flat contradiction with generally admitted ideas, the more so, since the publication of the exciting work of Commander Semenoff entitled, "The Death Struggle of a Battleship" ("L'Agonie d'un Cuirasse"). Reliable works on the Russo-Japanese War are still rather rare, and we lack a sufficient number of the accounts of eye-witnesses to establish a critical comparison. We must recollect, in any case, that the Russian battleships were loaded with coal, stored in their batteries, about decks, and even in officers' rooms. Under these conditions, bursting shell could not fail to start small fires continually, the smoke from which was enough, without doubt, to produce asphyxiating effects. But we must give up this idea which was cracked up too much last year by Congress, the Press, and even certain circles of officers as a "bombardment with carbonic acid gas" by means of shells carrying large charges of explosive (high). Between projectiles carrying 5% and those carrying 10% of melinite, there is no great difference as far as the breathing effect, or the production of deleterious gases, is concerned; but there is a wide difference, on the other hand, in the power of penetration (of the projectile).

Now, in order to produce an effect behind armor, it is necessary to get through it; if the shell simply hits the armor, no action is produced on the other side. The charge of explosive should be increased only to that amount which will permit of attaining the required penetration (of the projectile). Practically, a bursting charge of 7 or 8% of the total weight of the projectile seems to be the maximum admissible for medium calibers; the *Jena* experiments permit of fixing upon this figure as a basis of calculation for the shells for the guns to be constructed in considering the ships to be laid down. (Note.—This must refer to the auxiliary batteries of 5.5-inch (14 cm.) guns proposed for the new designs of battleships.)

The effect on accessories, as observed, was very interesting, the rupture of steam pipes, for instance, but above all the electric leads and order transmitting arrangements. It was well known before the experiments that communication between the various parts of ships ran the risk of being interrupted in action, but the experiments showed that such interruption was more than probable as soon as the fire of the enemy is regulated. From this follows primarily the obligation of making every effort to obtain such regulation (range, etc.) first, a *sine qua non* of victory. From it also is shown the necessity of actively preparing for "decentralized" fire, i.e., firing left to battery and turret officers. The fire control officer (of the ship) should without doubt be able to assure the first regulation (of the fire); but it is necessary to look forward to a time following that when the initiative of officers and petty

officers at the guns may be complete, and they must be prepared for a role which is eminently difficult and of capital importance.

After the *Conde* and *Lalouche-Treville*, a 24 cm. (9.45-inch) gun placed on shore took up the fire. It was a case, this time, of experiments with the "P" shell and the lengthened shells used by the coast batteries, not against the underwater part of the hull, as in the case of the *Admiral-Duperre* experiments, but against the superstructure parts. This served only to confirm what was already known and what we have stated above: the shell with thin walls and large charges having no penetrative power, burst without going through, and produce damage only to the plates they strike.

The "P" shells are not effective against the armored parts of ships, however thin, any more than was the famous Gathman shell tried in the United States in 1900. The Minister of War who, as is known, is responsible for coast defense, affirms that these shells are made to hit ships only below their water-lines, like torpedoes, and that the methods of sighting and conduct of fire employed in the batteries (coast) gives a certain chance of success ("quasi-certitude de réussite").

We hope that this affirmation is solidly founded, for if it were otherwise, the value of our coast batteries, exclusively provided with shells of this kind (?), would be singularly reduced.

The series of fires now in progress is being made with the 12-inch guns of the *Suffren*. Three kinds of projectiles have been used: the common shell, semi-rupture shell, and the heavy shell. It is known that the first two form—since cast-iron shells were abolished—the allowance for all our battleships including ships of the *Patrie* class. They were already too well known to do otherwise than verify their qualities. The semi-rupture shell has shown perforation qualities equal to those expected, even at an angle of 40°, which is outside of the usual trial limit. As for the heavy shell (970 pounds instead of 750 pounds) which the guns of the *Danton* class will use to the exclusion of all others, the trials with it have been extremely favorable. It responds entirely to the ballistic conditions laid down in its design, and the effects, not only in penetration, but consecutive explosion, are overwhelming. The members of the Budget Committee of the Chamber of Deputies who were present on October 9 at the first fires, do not hide the impression that the results made on them. These shells contain 37 pounds of melinite, i.e., 4% of the weight of the projectile only. But it must be remarked that the weight of explosive for shells of large caliber can, in proportion, be less than for shell of small caliber, provided that this bursting charge is large enough in an absolute way: the primordial requirement for guns of the largest caliber is that there should be nothing that can resist them (their attack). As a matter of fact, the armor of the *Jena* has been perforated several times at the water-line, or about there, and the vessel grounded, because of the water that entered through the breaches.

Besides the effect produced by the projectiles, the firing has permitted a study of the important question of the sensitiveness of their mechanism for exploding them (fuzes, in other words). Different fuzes already tried at Gavres have been used, with the 12-inch gun as well as with the 5.5-inch and 7.4-inch guns. These fuzes, placed in the base of the projectile, are all founded on the principle of centrifugal force; they arm automatically when the shell has gained its maximum speed of rotation, i.e., when it leaves the muzzle of the gun, and they bring about the explosion when this speed (of rotation) is suddenly reduced by the entry of the projectile into the armor. Their regulation is naturally quite delicate, because they must not act on contact and they must,

however, be sensitive enough to act against thin plates. They have been able to experiment with different designs—French and foreign—and draw from them precise information for future material.

If the *Jena*, badly damaged, naturally, by the projectiles received, remains afloat after the series of trials now in progress, it will remain to fire at an actual distance of 6500 yards, as requested by the Board, to verify the data established, as we have stated, at a fictitious distance. This will be the crowning of the extremely fruitful experiments that have been going on for two months. What we must retain above all as a result of these experiments is the feeling of comfort they bring. After so many attacks directed against all ships of the Navy, one is pleased to note the exaggerations of certain critics and above all those that have been brought at times with so much harshness against the corps of Colonial Artillery charged with preparing materials for action for our ships. No future doubt can exist, at least in all that concerns projectiles, that its work—in concert, moreover, with that of the General Staff—has been conducted in the right path.—*Le Yacht*, November 6, 1909.

THE JENA FIRINGS

Firing experiments on the *Jena* were continued last week by trials of the 12-inch shell of increased weight, and it is stated that the results were most satisfactory.

That this shell should be a very good and even excellent projectile, that it should be the best we have in our stock, is by no means a surprise, and it was already anticipated that it would give, on the *Jena*, a proof of its efficiency. But, with its small charge of explosive it is still an armor piercing projectile, or rather, it is only a compromise which seeks to satisfy at the same time partisans of perforation and those who advocate explosion outside.

However, it must be stated, these latter do not declare themselves entirely satisfied with this compromise solution that the naval ordnance officers have furnished them. They still regret that these officers did not persevere along the lines on which they had entered 20 years ago, when they invented the cast-iron shell charged with 10% of melinite, which gave us, at that moment, an incontestable superiority over all of the artilleries of other naval powers. This shell, however, soon no longer possessed the resistance necessary to enable it to be fired from the new guns without danger. In the constant endeavor to attain greater perforation, it was necessary to accept higher and higher pressures, to get greater initial velocities.

But that was not a reason for abandoning the improvement of this shell and its adaptation to the new guns. It is only quite recently that shells have been made carrying 10% of melinite and suitable as regards metal and resistance to be fired in guns using heavy propelling charges and attaining great velocities.

What they ought to have done was to find a shell carrying 15% or 20% of explosive, as did the Army, when they considered and adopted for the coast batteries the famous "P" shell. The heavy 12-inch shell with which the *Danton* class will be armed does not yet satisfy the partisans of shell of great capacity. They recognize the fact that this new shell will carry 29 pounds of melinite for 970 pounds total weight, whereas the present shell carries 18.7 pounds of melinite for 750 pounds. But they still reproach naval ordnance officers with not having been radical enough or revolutionary enough to break for once and all with the errors they have followed too long.

In support of their statements, the partisans of shell of great capacity cite the example of foreign powers which in general use shell carrying 10% of explosive in modern guns.

In his statement before the board of inquiry, General Gossot expressed himself as follows: "The officers of the navy who, rightly, desire to be armed as efficaciously as possible, are always demanding a heavier shell;—we have it, but of greater capacity for carrying explosive. When they speak of great capacity, they mean more than 3%. They say, the problem is not unsolvable; the English have already in use a shell that is not yet in service for the heaviest calibers—for the 12-inch—but which can be used for guns of considerable caliber, the 9.45-inch, and which contains 10% of its weight of lyddite." The general added: "I have had the question thoroughly examined. Since foreign powers arrive at 10%, practice shows that this is the figure we should keep in view.

Officers of the navy, therefore, were justified in thinking that their ordnance constructors would very soon give them this shell. They were all the more anxious to have it when they studied the lessons of the battle of Tsu-Shima, where it is more and more certain that it was not so much the maneuvering superiority of Togo over his adversary as the superiority of the armament of the Japanese over that of the Russians, which decided the victory. This superiority was manifested by the now celebrated explosive shell that the Russian officers called "valises" or "hand-bags" to characterize the large amount of explosive they contained.

The stirring account of Commander Semenoff leaves no doubt in this regard. "It seemed", he says, "that it was no longer ordinary projectiles that struck our sides or fell upon our decks, but whole mines, and these mines exploded as soon as they met the slightest resistance. Such a carnage could never have been caused by the simple shock of a projectile, still less by its fragments; it could result only from an extraordinarily powerful explosion. All that would have been little enough, however, if, in addition, there had not been a terrible elevation of temperature and an avalanche of liquid iron that covered everything" *** etc.

In an article that appeared in the *Revue de Paris*, of September 15, 1909, an anonymous writer, whose competence is evident on every page, has made himself the eloquent and persuasive defender of the projectile of great explosive carrying capacity. Naturally, he also cites some of the characteristic passages of Commander Semenoff's book. Going to the very bottom of the question, he does not hesitate to demand that our artillery should go ahead with the "revolution" mentioned above.

He explains that our artillery officers were wrong in wanting to find an explosive-carrying projectile strong enough to stand the pressures of modern guns;—he insists that their first and only duty was to find a projectile having "the maximum utility as an agent of destruction," even if, to accomplish it, they had to give us another artillery, even if they had to disregard all theories based on the necessity of the perforation of armor.

For him, the real question was the following: "To construct a gun having sufficient power to make it the equal of other modern guns, but also rendering it possible to adopt for it a projectile of large explosive capacity, bursting upon shock, whatever be the obstacle." This gun, he says, would not require initial velocities exceeding 1950 foot-seconds.

All this article should be read. We must here limit ourselves to indicating its spirit and tendency. However, we will reproduce the conclusions, as they

are of a nature to make many reflect: "Why have we not already adopted initial velocities of about 2000 feet, velocities which alone permit the use of a shell of great explosive capacity, such as the "P" shell? The advantages of such a reform, from the point of view of materiel, appear to be considerable. They may be summed up in the following: diminution of the weight of guns and all their accessories; reduction of the cost price; increase of the number of guns and projectiles; or else, increase of speed and radius of action. This would be a new materiel."—*Moniteur de la Flotte*, November 6, 1909.



THE FIRING AT THE JENA

According to *La Vie Maritime*, the tests of the famous "P" shell against the *Jena* have proved that design of projectile (supposed to be a blunt-pointed, high-explosive shell intended to act against the underwater bodies of ships), to be exceedingly ineffective. The latest firings have been made with the 12-inch guns of the *Suffren* to determine the relative effects of three types of shell, the existing service A. P. shell and semi A. P. shell, and the new design of shell intended to be supplied to the *Danton* class. This latter type is an A. P. shell of 970 pounds total weight, carrying a high explosive charge of about 29 pounds, and designed to penetrate thick armor before bursting.

One result of these experiments has been to demonstrate the utter absurdity of the idea that the crews of ships can be decimated by asphyxiation by the fumes of high explosive shell. Dogs, rabbits and pigeons placed on the *Jena* suffered no harm unless they were hit by fragments of the exploding shell.

—*Proceedings United States Naval Institute*, December, 1909.



COAST AND HARBOR DEFENSE IN THE LIGHT OF THE TEACHINGS OF THE RUSSO-JAPANESE WAR.*

By Captain BRACHT of the Von Hindersin Regiment of Foot Artillery.

Translated from the French by Colonel ALBERT TODD, Coast Artillery Corps.

A Russian author, Mr. Treidler, has recently published in the *Journal of Russian Artillery* a very interesting study upon coast defense, basing it upon the lessons drawn from the performances of the naval and coast artillery in the combat of July 28, 1904, and the battle of Tsu-Shima, as well as upon the part played by the seacoast artillery in the siege of Port Arthur. The part of this study which is especially interesting relates to the effects of the projectiles used by the opposing combatants. We give below an extract from this study.

Note: In the following, we, our, etc., refer to the Russians.

The history of maritime warfare, especially during the past fifty years, shows that the defense of the seacoast has a much greater importance in its influence on campaigns than the defense of interior fortresses. The loss of a seacoast fortress often decides the fate of the entire campaign. (Sebastopol, 1855; Charleston, 1865; Alexandria, 1882; Port Arthur, 1904.)

Now, the defense of these fortresses depends almost wholly on the action of the coast artillery, upon which devolves the following tasks:—

1. To hinder the enemy's fleet from carrying the fortress by an attack in force, that is to say, by forcing the entrance of the harbor after having silenced the guns of the forts.

*Furnished for publication through the courtesy of the Second Section of the General Staff, U. S. Army.

2. To insure a refuge for the friendly fleet, when the enemy's fleet is mistress of the sea.

3. To prevent the enemy's fleet from bombarding at long range the storehouses, magazines, docks, etc., of the place fortified.

4. To hinder the enemy's fleet from making use of neighboring bodies of water, either as a base for operations on the open sea, or for debarkation, and thus rendering impossible a blockade of the place on the land side.

It is clear that there must be on the part of the fleet a very great superiority in guns, not only in number but in efficiency, in order to overcome the guns on shore; this was once more shown in the struggle between the Russian seacoast guns and the Japanese fleet.

And this will always be true, although in many of the seacoast works as they now exist, neither the emplacements nor the number and power of the guns are all that is demanded by modern conditions of warfare. On the contrary, there are very few coast fortresses that are really in condition to serve all of the foregoing purposes.

I. DEFENSIVE BATTERIES*

Although as we have seen the present coast fortifications are in general powerful enough to repulse an attack by the enemy's fleet, it is none the less true that they are seldom pushed far enough to the front to protect the main part of the fortifications from high caliber marine artillery, which can bombard at distances of nine and eleven kilometers (five and one-half to nearly seven miles). Fortified works should therefore be erected further to the front, creating, if need be, artificial islets for the purpose. It must not be lost sight of that the range of naval artillery will go on increasing every year. A French writer emphasized this in a work entitled *Coast Defense*, published in Paris in 1899.

These batteries and advanced forts should form therefore the first line of defense, while the present fortifications should be the second line. There should be special batteries to oppose the attempts of the enemy's fleet to force its way into the harbor.

As it is the role of these outer works to keep the enemy as far off as possible, this line of works should have guns of long range; large caliber mortars should be in the second line.

II. GUNS AND PROJECTILES FOR DEFENSIVE BATTERIES

The role of Coast Artillery depends not only upon the target presented to it, but even more upon the destructive effect of the projectiles used. As the struggles at Port Arthur and the battle of Tsu-Shima prove, ships are put out of action, even sunk, not alone by projectiles piercing the armor, but also and oftener by other projectiles striking the ship above the water line, or to speak generally, by projectiles which destroy or damage the thinly protected parts, or those not protected at all, situated above the water line, representing as to weight 72 to 75% of displacement. It is of great importance that the ship should be able to resist the water penetrating through the holes pierced above the water line and that it may not take fire easily under the enemy's projectiles. Inflammable materials are found in quantities on armored ships and Colonel Meller says on this point: "The war of 1904 has proved that ships may be sunk without a hole being pierced in the armor; all that is necessary is that

* "*Batteries de Protection*" in the text. It is doubtful if "Defensive Batteries" is the proper translation but no better one can be thought of.—Translator.

telling blows be delivered on the parts situated above the water line." But the most efficacious means of destroying these armored ships is by fire, as we shall see later on.

Before the war there were two opinions, flatly opposed to each other. On the one hand, it was expected that the end would be attained by piercing the armor at the water line by armor-piercing shell, or shell provided with but a light bursting charge. On the other hand, it was thought that the chief effect would be attained with elongated shell with thin walls loaded with a powerful explosive charge, which would strike the superstructure, and would not render it necessary to pierce the armor at the water line, or to reach the engines and boilers.

After the experiments in firing against the armorclad *Belleisle*, the English favored the first solution, while we adopted the second, concurred in by the French up to the war of 1904.

Our naval artillery possessed two sorts of projectiles loaded with gun-cotton; the armor-piercing shell with an explosive charge of from one to two per cent of the weight of the projectile, and provided with a delayed action percussion fuse; and elongated shell with fuses not of the delayed action type, with an explosive charge of from two to three and four per cent of the weight of the projectile. As this latter charge is still much inferior to that of the English armor piercing shell it may be said that we did not possess any torpedo shell properly so called. In the late war our ships were provided principally, with armor-piercing shell with a very decided delayed action percussion fuse. The fuse was not at all sensitive, so little so that many of the projectiles did not burst, even after piercing light armor.

On the contrary, the Japanese ships were provided, for the most part, with torpedo shell loaded with melinite (a heavy charge, amounting to nine and one-half per cent of the weight of the projectile) and armed with a very sensitive non-delayed-action percussion fuse.

(a). *Firing experiments against the armor clad Belleisle in 1900.*

There were fired against this ship ordinary armor-piercing shell as well as lyddite shell, with the following results:—

1. After a bombardment of three minutes with lyddite shell, the whole ship was enveloped in fire and flame.

2. The effect of the gas and of the fragments of the shells was very marked. The crew represented by mannikins of straw were injured wherever they were on the ship.

3. The lyddite shells destroyed the deck, making great holes in it with the edges bent inward. The effect of shells filled with black powder and those with lyddite are not to be compared. The lyddite shells reduced wood to powder; not only the fragments of the shells but even the burning gas evolved did great damage, even melting iron. When the lyddite shell burst a thick black smoke was evolved. The various effects produced showed that melinite is three times as effective as gun cotton.

After this experiment all the powers, Russia excepted, decided to load their shells with melinite or with lyddite. The shimose powder of the Japanese does not differ materially from the explosives above named.

The naval combats around Port Arthur, the battle of Tsu-Shima, and the bombardment of the roadstead of Port Arthur, a bombardment from land, have cleared up and definitely decided the question of projectiles and of the guns for use in an action against modern warships.

(b.) *The battle of July 28, 1904.*

According to the testimony of the onlookers as well as of those who participated in the engagement, the effect of the Japanese shells was very considerable. The Japanese opened fire at 14 kilometers (nearly nine miles) continuing the fire at lesser ranges, 13, 10, 8 and 7 kilometers and finally at 3700 meters, (8, 6, 5, 4½ and 2½ miles). "At the long ranges," says Captain Von Essen commanding the *Sebastopol*, "it was impossible to determine where our shot struck, as the color of the cloud of smoke produced from our bursting shells could not be distinguished from the color of the smoke of the enemy's guns."

The Japanese, on the contrary, could readily see where their projectiles struck, thanks to the black smoke produced. There were no telescopic sights on our guns, so that it was impossible to aim accurately upon the very small and often indistinct objectives. At ranges between 7 and 3.6 kilometers (4½ and 2½ miles) our ships were frequently struck, causing fires to break out on nearly all of them. On the battleship *Peresviet* the yards and topmasts were destroyed. The *Sebastopol* sustained the following damage:

1. In the middle on the larboard side two casemates were crushed in.
2. Two projectiles struck the armor near the 15 cm. turrets. The first of these shattered a plate and caused an explosion inside the ship; the second bent a plate inward.
3. There were several penetrations above the water line; three at the bow, just at the water line, penetrating into one of the apartments of the crew; three others in the deck battery.
4. The two smokestacks were pierced in several places, as was also the mizzen mast and the main yard, as well as the yards for the wireless telegraph.
5. All the bridges were covered with splinters of shell, a great hole was made in the deck and all the upper works were injured.
6. All the steam pipes as well as the ventilating shafts were destroyed.
7. All the launches and ship's boats, all the searchlights, all the deck compasses, were rendered unserviceable.
8. All the reserve steam pipes (?) were bent.
9. The electric rotating apparatus of the 15 cm. turrets was put out of action.
10. The chase of a 4.7-mm. (1.83-inch) gun was demolished.
11. The torpedo net on the larboard side was torn off.
12. Six officer's cabins on the larboard side were destroyed.

Generally speaking, the injuries sustained by the other ships were even more serious. Many projectiles pierced the hull below the water line. The losses in men were not important. In all the combats, as well as during the various bombardments of Port Arthur, small Japanese cruisers hovered on the flanks of our fleet, maintaining an enfilade fire on our ships.

The injuries caused by projectiles not having delayed action fuses were the most dangerous and this for the following reasons:

1. It was very difficult to close with the pieces of wood provided for the purpose, the holes made in the sides of the ship on account of the large size of these holes and because their edges were bent inward. Therefore the water poured in a flood, whenever the ship rolled, if the hole was near the water line.
2. The damage in the interior was of necessity greater, because not only the fragments of the shells, but also pieces of the sides of the ship were projected violently into the interior, together with rivets, bolts, etc., as well as debris from the arches. So far as can be determined but a small part of the

fragments of the projectiles impinged on the outer walls of the hull, the greater number reaching the inside. Even the pieces which struck the exterior did serious damage by tearing the torpedo nets, for example.

It is imperative to use projectiles which will interfere with the maneuvering of the ship rather than those which simply pierce the plates and may damage the interior. Therefore all shell should be provided with very sensitive, non-delay-action fuses, and those which are armor-piercing should have fuses which will act just as the projectiles are piercing the plates.

Armor-piercing shells of this kind tear the bolts out of the plates, cut the armor-backing and even break the plates themselves in pieces. For such projectiles a very brief delayed action fuse is therefore sufficient.

After the fight all the ships, according to an eye witness, came slowly back to Port Arthur, some heeling over to the right, some to the left; smokestacks and masts were destroyed and the chases of many of the pieces were broken by the enemy's projectiles. On deck everything was in ruins, everywhere iron debris. In the sides of many of the ships were holes large enough for several men to stand in side by side, and as a last sad thing to chronicle, there were dead and wounded in great numbers. The damage caused by our semi-rupture* shells on the Japanese ships was evidently much less. The Japanese authors say that many of our projectiles did not burst, probably because the fuses were not sufficiently sensitive. Five of such shells struck the cruiser *Iwate*, and one penetrated the engine room of the torpedo boat *Chiodori*.

(c.) *The battle of Tsu-Shima.*

This battle demonstrated in a still more striking manner the superiority of torpedo shell over armor-piercing shell and the semi-rupture shell. This is shown at all ranges. The battleships *Oslabia*, *Svaroff*, *Borodino* and *Alexander III* were put out of action and sunk because the formidable explosive charges destroyed everything above the water, all the superstructure including the armored turrets, the guns and the mounts. Where these shells struck the armor plates were torn in pieces, the iron companion ways twisted into spirals, the smokestacks and masts demolished, the deck cabins destroyed by fire, the range-finding and signaling apparatus rendered entirely useless; heaps, mounds of corpses were piled up everywhere. Eye-witnesses declare that the effect of the torpedo shell was as if actual submarine torpedoes had been discharged upon the ships' decks. The armored turrets were destroyed, the guns torn from their mounts, *even without being struck directly by projectiles.* The attack by torpedo boats was but the finishing touch in the destruction of these four battleships; which is to say that *the battle was decided exclusively by artillery fire.*

The naval battle of Tsu-Shima demonstrated one other thing entirely new. Eye-witnesses declare that all our armored ships went down in a veritable mantle of fire and thick smoke, the result of a sort of Greek fire. Semenoff who was upon the *Svaroff* states that *on the explosion of the shells, the paint on the ship took fire, and the hammocks and chests of the men though protected by iron partitions and soaked with water, flamed up in an instant like a taper.* At times it was impossible to see even with the aid of glasses, so great was the heat. Semenoff, who had already taken part in the battle of July 28th, declares, that at Tsu-Shima the effect of the torpedo shell was even more terrible than on the 28th, because at Tsu-Shima the projectiles burst at the slightest touch with any

* The expression "semi-rupture" in the French is preserved, as the exact translation therefore is not known, no dictionary obtainable giving the English for this.—Trans. See p. 49, this Journal.

object encountered in their flight. However, it was only the 30 cm. (12-inch) shells from the Japanese battleships which were especially formidable. Semenov says that the shells from the cruisers did not have any great explosive power, and started no fires of any importance. The Japanese torpedo shell must have contained some inflammable material, naphtha, petroleum or oil, which upon the burst of the projectile spread everywhere and started the fires. At the same time there were produced clouds of choking gas. In consequence every ship on which fire broke out above the water line soon dropped out of the fighting line. The personnel at the guns, at the range-finders and the signal apparatus naturally hurried to fight the fire only to be at once asphyxiated by the smoke and heat. The ventilators no longer carried air below, only this choking smoke, and all the men in the engine rooms were quickly stifled. The engines stopped, the electrical installations ceased to function. The maneuvering of the ship, its fire and the transmission of messages, were impossible, and the ships could but drift about purposelessly, leaving the fighting line, with their armor, machinery and boilers unharmed and even with the fires extinguished in a great degree in some cases.

The most efficacious projectiles which can be employed against any warship is therefore the bursting shell charged with a strong combustible to carry fire in all directions and to produce a great mass of choking gases at a high temperature. Upon the *Suvaroff* officers and men of the crew were even asphyxiated on the upper deck.

Semenov further states the following concerning this tragedy on the *Suvaroff*: "It seems altogether probable that all those who were in what had been considered protected places but into which instead of air only smoke was conveyed by the ventilators, were asphyxiated. The engines no longer operated, the electric lights went out and yet no one came on deck. Of the 900 men of the crew all had perished, at that moment, that is, scarcely three hours after the beginning of the action, save a few odd men who were at the lower battery on the windward side."

The *Suvaroff* was out of action within barely an hour and a half after it had fired its first shot. Fifteen minutes after the beginning of the battle fires had broken out on all the battleships. And at the end of forty-five minutes the *Suvaroff* was enveloped in flames; communication from bow to stern was entirely broken, the staff quarters were burning, the after turret was destroyed, the smokestacks were demolished and the rudder bent. The range-finding and signal apparatus had already been destroyed and the guns, save one or two, silenced. The situation was much the same on all the ships at the time we are speaking of.

At 2:40 P.M. serious fires were raging on the *Alexander*. At 6:00 this ship had sunk almost to the ports of the lower battery. There was a rent extending from the bow to the 30 cm. turret; the stern gaped wide open. There were holes in the sides, and by 6:30 the ship rested on its side. The poop was much damaged by fire. The *Borodino* was first pierced at 3:30 P.M. This shot struck the ship at the stern on the starboard a little above the water line. A fire broke out at once and the water poured through the rent in the side. About 5:00 a shell pierced the armor, exploding as it entered the side and deck. Another shell destroyed the captain's bridge and its fragments carried away the cap of the 30 cm. forward turret. The shells shattered and burned everything they came in contact with. The officers' as well as the admiral's cabins were completely wrecked and burned, as was also the deck.

The *Oslabiya* was struck under the water line and the ship soon careened.

The forward turret, 25 cm. (10-inch), was put out of action in a very short time, several projectiles striking it. At the end of thirty minutes all the guns were out of action except those of the after turret and the other guns at the rear. At the end of an hour three projectiles struck the poop almost at the same moment, a little above the water line, and made a hole large enough for "three horses abreast to go through." The water entered in a torrent, for the boards applied to keep it out could not stand the pressure. Another projectile pierced the side near the 16th coal bunker letting the water in between decks.

The *Sissoi Veliky* was struck by many shells on its armor but was not pierced. Very considerable fires were started by two projectiles which entered the battery, one just about the water line, the other between decks. The officers and men called the Japanese shells, chests or trunks. Mines or aerial torpedoes would be a better name, from the effect they produced. As for our Russian projectiles they had but little effect. As we have already said, it was not possible to distinguish the flame of the burst of our shells from the flame of the Japanese gun fire. At a range of 3500 meters (3900 yards) after an engagement of scarcely 15 minutes, the bridges were burning like straw, the range-finders and signal apparatus were destroyed; heaps of corpses strewed the deck. While the *Alexander* and the *Borodino* were enveloped in flames nothing of the sort was to be observed in the Japanese fleet. Men could be seen on the bridges, there was no fire, no listing of any ship, not a bridge destroyed. It was plain that our projectiles did not burst, or if they did, only into large fragments. There were in all but 527 Japanese killed and wounded, of whom 8%, or 42 men, had but trifling wounds.

It is impossible to put on any ship armor impregnable against the impact of several torpedo shell or semi-rupture shell, if these strike close together. Moreover the most absolutely indispensable parts are not those protected behind the band of armor, that is to say, it is not the boilers and engines, which are the real life of the ship, but rather the parts above the water line, the apparatus to control the maneuvering of the vessel, the batteries, the observation apparatus to control the maneuvering of the vessel, the batteries, the observation apparatus, etc. As the load on the ship when ready for action is always a little greater than normally, there remains a band of armor of from but 60 to 90 cm. in breadth, (24 to 36 inches) above the water line, to fire at. And as the gun pointers usually aim at the upper edge of the vessel more than 50% of the shots strike above the water line. For these various reasons it is evident that the projectiles to be used are not those to pierce the armor, but to destroy the upper works; and these projectiles should be torpedo shell or semi-rupture shell with a heavy bursting charge. The battle of Tsu-Shima proved anew that the real strength of a ship or fleet, as well as of each battery of a fortress and consequently of the fortress itself, does not consist in their armor plate, parapets or traverses, but simply in the power of their fire. This depends not only on the caliber, the range and the speed of fire, but even more on the destructive power of the projectiles, and this latter depends not alone on the $\frac{mv^2}{2}$

but as well on the explosive energy of the charge. Now, the great advantage of the torpedo shell over the ordinary armor-piercing shell, is that this energy is not dependent on the range. This was sadly brought to our attention in the different recent naval conflicts in Asiatic waters. Our armor piercing and semi-rupture shell simply made round holes in the enemy's armor plate, because the fuses were not sufficiently sensitive. These projectiles were made for combats at short ranges, while naval battles are now decided at middle or

long ranges. The effect of the Japanese (English) shell, 30 cm. (12-inch), charged with 36 kilograms (80 lbs) of melinite is at least 15 times as great as that of our 30 cm. shell charged with 6.5 kilograms (14 lbs.) of gun cotton.

It is not the greater speed of the Japanese ships, nor the kind of armor, nor the greater load on our ships, nor the superiority of the Japanese as to personnel, material, or number of guns of medium caliber which decided the naval battle in Asia, but simply the torpedo shell opposed only by an armor-piercing shell and a semi-rupture shell with a weak bursting charge.

(d.) *Bombardment of Port Arthur.*

Concerning this phase of the war we have the testimony of Von Essen and of the English reporter, Rait, who visited the battleships *Pallada*, *Persviet*, *Retvizan*, and *Pobieda*, after the bombardment. The 28 cm. (11.2-inch) shells fired from the Japanese howitzers striking with an angle not under 60 degrees, caused frightful havoc upon the ships, sinking them all. The shells burst inside the vessels, the fragments piercing the decks and partitions. The *Pallada* showed traces of having been on fire. To protect the decks, sacks filled with coal, hawsers, etc., had been spread over them. The Japanese shells had pierced the deck, covered it with oil and set fire to all this covering. It was the same on the *Persviet* and the *Retvizan*. The *Pobieda* had suffered the most. As it was lying on the bottom heeled over at an angle of 35 degrees, the damage done by the projectiles could be seen perfectly. The visitors aver that no warship could have stood the impact of the projectiles from these great guns at the high angles of fire employed. It was not the piercing of the sides but the action of the explosive upon the superstructure and the resulting fires which put the vessels out of action. The *real strength* of naval artillery as well as of seacoast guns *does not consist, therefore, in being able to fire a maximum of metal in a unit of time*, but in being able to charge their projectiles with a very large quantity of very strong explosive. And this is the great secret which explains our naval defeats in the late war. It is therefore beyond doubt that the principal projectiles for our naval and seacoast artillery should be torpedo shell with a heavy charge of bursting powder.

As the distances at which naval combats take place is ever growing greater, the range of the coast guns must also be increased to the limit and all guns should have telescopic sights. The conclusions to be drawn from all that precedes are as follows:—

1. The most suitable projectile for all ranges and against all parts of the ship is the torpedo shell filled with a large charge of bursting powder, to insure a heavy explosion, to set free a large quantity of gas at high temperature, as also a black and asphyxiating smoke.

2. At all the mid-ranges the action of the torpedo shell against the less protected parts of the ship should be supplemented by semi-rupture shells with a large charge of bursting powder.

3. The best shell for armor piercing at middle and short ranges, as well as for piercing the deck at all ranges is the semi-rupture shell with percussion fuse, which causes the projectile to burst just as it pierces the armor, or as it pierces the deck.

4. The percussion fuses of torpedo shell should be very sensitive, that is to say, they should not be of the delayed action type; the fuse for semi-rupture shells should have a slight delayed action.

5. Above all, in firing against modern vessels, the projectile on exploding should produce a quantity of dense smoke.

Hence the following important deductions as regards coast artillery:—

1. As the principal struggle between coast works and the fleet will begin at long ranges, the principal projectiles for the batteries should be torpedo shell.
2. In defensive batteries there should be but few semi-rupture shell as these are to be used at middle and short ranges. But these are the best projectiles for repelling close attacks and the proper ones for all mortars for action against decks at long as well as mid-ranges.
3. Armor piercing shells without bursting charge should be regarded as obsolete.
4. The principal guns for defensive batteries are of three types: large caliber, medium and small. To repel sharp attacks there should be large and small calibers. Mortars find their place in the defensive batteries of the second line.
5. All long range guns should have telescopic sights. Guns of medium and small caliber should be rapid fire.

III. BATTERIES TO BE ESTABLISHED NEAR MARITIME PLACES

Seacoast fortifications at present are not up to their proper role, which is to guarantee to the friendly fleet an assured refuge and to protect the port from bombardment. They are still less in a state to prevent the enemy's fleet from making some neighboring port a base of operations and to use that base to make an attack by land. The history of maritime wars shows, however, that most seacoast works have succumbed to attacks from the land side. If the bays and neighboring ports were covered by curved fire guns established out of sight of the enemy, his fleet could not penetrate them and the struggle between the fleet and batteries would be wholly in favor of the batteries. And the situation would be practically the same even if there were curved fire batteries on the ships.

The obstructing of neighboring waters by submarine mines without having land batteries to cover the mine field would retard the enemy's debarkation but slightly. This is shown by what happened in the late war at Dalny. The construction of batteries of this kind for shelling the bays and harbors in the neighborhood of maritime places which might be suitable for attempts at disembarkation is therefore absolutely indispensable. Generally the number of these batteries need not be great, for one battery can often shell several of these nearby waters. The best type of guns for these batteries is the seacoast mortar on a circular platform with a field of fire of 360 degrees, so that they may fire in every direction, even landward. These batteries should be a part of the general system of works. It is evident also that if the terrain demands it there should also be some gun batteries. Considering the efficaciousness of the 28 cm. (11.2-inch) howitzers in their action against armor at Port Arthur, the principal projectile will be the 28 cm. torpedo shell, with some semi-rupture shells which will be effective against the decks. It is vitally necessary that these batteries should be so located as to be invisible from the sea, and as little as possible from the land side. The range from the batteries to the objective may be from 4 to 8 kilometers (2½ to 5 miles). As it would be often necessary to put them at a great distance from the main works, it will suffice to shelter the pieces in magazines or sheds near the positions in which they are to be used. This will simplify the matter of caring for and guarding them. These shelters should be connected with the emplacements by a railway so that putting the piece into battery may be effected quickly. *All the batteries of the main works should be connected in the same way and to the detached batteries as well.* The cars on this railway should be able to carry a load of 30,000 kilos., (66,000 lbs.). This

railway will also be of use to move the train batteries from place to place, the guns of which are designed to be fired from the cars, special fittings permitting this. One of the northern fortresses has a train of this kind.

IV. FORTS AND BATTERIES ON THE LAND SIDE

Despite the detached batteries of which we have just spoken, the enemy may succeed under certain circumstances in disembarking and attacking the place from the land side. Maritime fortresses must therefore be protected by a system of forts and batteries against attempts of this kind. The Port Arthur casemates were not proof against projectiles greater than 15 cm. (6-inch), it not having been thought that guns of greater caliber could be brought against them on the land side. But despite the mountainous terrain the Japanese brought up by rail 28 cm. (11.2-inch) howitzers weighing 15,000 kilograms (33,000 pounds) as well as some 15 cm. naval guns. In the future the presence of such guns must be counted upon at all fortresses and the works must be protected against projectiles of these guns. To oppose these guns the forts should have howitzers firing torpedo shell and shrapnel, and these should be mounted not on elevated ground but rather in places completely sheltered from the view of the enemy.

It was not thus at Port Arthur. And we found ourselves forced very soon as the siege went on to install guns in protected places outside the main works. Many of these later works were never touched by the Japanese shells.

This short exposition shows clearly how much there remains to do in this respect in our seacoast fortifications.

V. BATTERIES TO DEFEND APPROACHES TO THE FORTS

It will always be well to defend the entrance to all ports in certain coast regions by establishing at least one battery, even if the guns be somewhat out of date, drawn from the seacoast armament or from war vessels. These batteries often might hinder any attempt at disembarkation. No such disembarkation is of any use or even possible unless the enemy is in secure possession of the port. The guns and munitions might, if necessary, be stored and taken care of in neighboring fortresses, and the emplacements might, if need be, be constructed by pioneers as a part of their drill and exercises.

VI. COAST DEFENSE

As the communications between coast works and in consequence the operations of putting them in a defensive condition may be seriously interfered with by the sudden appearance of the enemy's fleet, the construction of a railway withdrawn from the view of the enemy and linking together the forts of a whole fortified coast in the same way that belt railways connect all the works of an interior fortified place, is an inevitable necessity. The rolling stock of this railway should be capable of carrying the heaviest loads and there should be branches to the important arsenals, depots of supply, etc. In addition there should be telegraphic and telephonic communication, carrier pigeon service, and arrangements for visual signaling. Wireless telegraph stations should be installed on the most dominating heights in the vicinity.

Coast defense ought not to be simply passive or defensive, that is to say, it will not do to simply await the action of the enemy's fleet, but in advance the defense should prepare itself to oppose actively any attempt at disembarkation which they might dare anywhere along the coast. In war, there is reaped the fruits of peace preparations. For this reason nothing should be put

off to the time when war is imminent, for the enemy's fleet will appear at an unforeseen time.

It is just to this system of *passive defense* on our part to which our adversaries in the Crimean and Manchurian wars owed their relatively rapid successes in the sieges of Sebastopol and Port Arthur. If the defense of these two strong places had been well assured in time of peace by the engineers and artillery, these places would not even have been besieged, or if besieged, it would have taken the enemy twice, or thrice, the time it did to carry the place.

[The above study should be full of interest for all those who like ourselves (the Germans) have to do with the organization of the defense of maritime places, or to contribute in any way to such defense.—Note by German translator.]—*Revue Internationale*, January, 1909. (Translated from the *Militär Wochenblatt*, Nos. 110, 111 and 112, 1908.

TRANSLATOR'S NOTE

The above is the result of a triple translation, first from the Russian into German, then from German into French and thence into English. It is very doubtful if all the exact shades of meaning in the original Russian have been preserved, but probably nearly enough so, as to give a correct idea of the gist of the author's studies. As will be noted there is considerable repetition, the importance of the *torpedo shell* being the burden of the article. The ideas of the Russian author as to this importance is certainly worthy of careful thought and consideration.—A. T.



THE HIGH SPEED ENGINE

PISTON AND SLIDE VALVE TYPES AND THEIR VARIATIONS

Development of the electric lighting industry was the real incentive to the manufacturer of the high speed engine. Early forms of dynamos had armatures of small diameter, necessitating great speed of rotation, which was at first obtained by means of a jack shaft belted to the engine. Poor regulation in the engine was by this means accentuated many times over in the dynamo and in order to reduce the ratio between the speeds of the driver and driven machine and thereby minimize the effect of poor regulation, higher engine speeds were demanded.

At the same time, dynamo builders were decreasing the speed of rotation of their machines, until the movement for reduced speed on the one hand and higher speed on the other, met in the direct-connected unit, which has resulted in the highest development of the high speed engine.

Another factor which has had no little influence on this type of prime mover is the crowded condition of our cities, where the high speed engine practically reigns supreme. To meet with modern office building requirements for instance, requires that the generating plant shall develop great power in small space and, of course, the higher the speed the greater the output for a given unit.

The matter of regulation which attained so much importance immediately on the introduction of the electric generator, has demanded the attention of the best engineers, and it is now common practice for makers to guarantee a speed variation of less than 2 per cent from no load to full load.

For the modern American high speed engine, the shaft type of governor has superseded all others, both the centrifugal and inertia principles being used.

As to valves in high speed engine work, two general types may be said to occupy the field, namely, the piston valve, an example of which is shown in Fig. 1, and the flat, balanced, multiported valve, invented by Prof. Sweet, and known by his name.

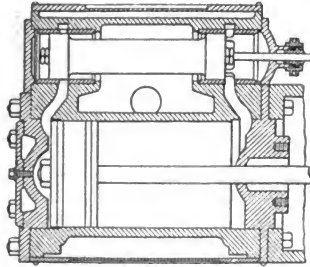


Fig. 1. Example of Piston Valve.

This valve which is illustrated in Figs. 2 and 3 consists of a flat body of gridiron construction, covered with a pressing plate *A* which makes a working fit over the valve and relieves it of the steam pressure.

It will be seen by the arrows in Fig. 2 that a double-ported action is obtained by arranging the valve ports so that steam is admitted both at the bottom and top edges of the valve. This action is also obtained on the exhaust edges by using the inner ports in the valve at *XX*, Fig. 2.

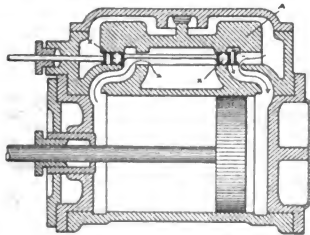


Fig. 2. The Sweet Valve, Showing Double Parted Action.

THE SLIDE VALVE

Once firmly established in the mind, the principles of the plain *D* slide valve enables the engineer to set the valves on any engine whether it has one, two, three or four valves to accomplish the cycle of operation. It is important before setting a slide valve to know that all the lost motion in the valve gear is taken up. Next, put the engine on one of its dead centers by tramming, as has been explained in another article.

Having put the engine on the dead center and taken up all lost motion in the valve gear, loosen the eccentric on the shaft and turn it in the direction the engine is to run until the valve has opened the port to the amount of lead. The position of the valve crank and eccentric will then be as in Fig. 4.

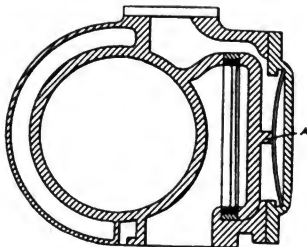


Fig. 3. Transverse Section Through Sweet Balanced Valve.

In deciding on what lead to give the slide valve, it should be remembered that the least lead that will allow the engine to run quietly will be the most economical. After setting the eccentric at this point, turn the engine over to the opposite dead center and note the amount of the lead. If it is more or less than on the other end, move the valve on the stem one-half the difference between the two leads, when the valve will be properly set.

The foregoing applies to engines having simple valve motions without rocker arms. If the engine has a rocker arm, which reverses the movement of the valve as shown in Fig. 5, the process is the same except that when setting the valve to the amount of the lead, the eccentric is moved in the opposite direction to that in which the engine is to run. A point to be taken into consideration with rocker arms is that when in operation they should move an equal distance on each side of their central position.

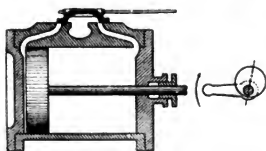


Fig. 4. Slide Valve open to the Amount of the Lead.

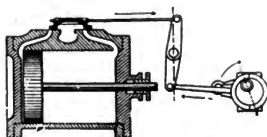


Fig. 5. Slide Valve with Rocker Arm.

In setting the Sweet valve, remove the pressure plate A, Fig. 2, thus exposing the valve to view, and proceed as with the ordinary slide valve, using the outside edge of the valve when determining the amount of lead.

PISTON VALVES

By referring to Fig. 6, the striking resemblance existing between slide and piston valves will be apparent. The operations take place in exactly the same manner, the steam ports being in this case, however, circular in form instead

of flat. Piston valves can be arranged to take steam either on the inside or the outside, and remain perfectly balanced in either case. In most designs, however, they are arranged to take steam on the inside, as it has the effect of relieving the valve stem stuffing box of boiler pressure, which is a desirable thing.

This type of valve is more puzzling to the engineer on account of the fact that the steam ports and the edges of the valve are not exposed to view, as in the slide valve engine, and different means have to be taken to determine its position.

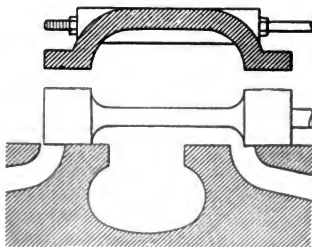


Fig. 6. Comparison of Slide and Piston Valves.

Before commencing operations, it is well to place the eccentric on the dead center next to the cylinder and scribe a mark on the valve stem and guide, which mark can be made to return the parts to their original position should occasion require to make a fresh start, which would otherwise be found difficult when the edges of the valve and steam ports cannot be seen easily. After

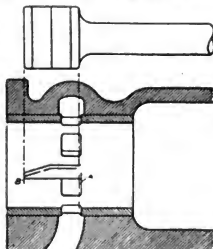


Fig. 7. Determining the Lead of a Piston Valve.

marking the original position of the valve gear, disconnect the valve stem from the guide block, take off the back steam chest cover, pull out the valve and stem and remove the other chest cover; make a template of thin sheet iron about an inch wide and about as long as the thickness of one of the pistons of the valve plus the lead.

Place the template against the inner side of the head end port *A*, Fig. 7, and with a scriber make a fine mark at the other end of the template *B*. In

TABLE OF DIMENSIONS, WEIGHT AND HORSEPOWER OF AMERICAN
HIGH SPEED ENGINES.

Size of Cylinder	Indicated Horsepower 100 Pounds Gage Pressure and 1/2 Cut-off	Revolutions per Minute	Flywheel		Steam Pipe Inches	Exhaust Pipe Inches	Length Over All		Width Over All		Weight of Engine and Wheels Complete Pounds
			Diameter Inches	Face Inches			Ft.	Ina.	Ft.	Ina.	
5×6	12	450	36	6½	2	2	5—11		2—11		1,200
5×8	15	375	36	5½	2	2	6—3		2—11		1,400
6×6	18	450	36	7	2	2	5—11		2—11		1,800
6×8	20	425	38	7	2	2½	6—6		3—2		2,800
6×10	22	375	38	8	2	2½	6—6		3—4		3,600
7×6	21	450	36	6½	2½	2½	5—11		2—11		2,900
7×8	25	425	40	7	2½	2½	6—4		3—4		3,000
7×9	28	400	40	8	2½	2½	6—11		3—6		3,400
7×10	28	350	42	8	2½	3	7—6		3—9		3,800
8×8	30	300	40	8½	2½	3	7—		3—9		4,000
8×9	32	300	40	8½	2½	3	7—		3—9		4,200
8×10	35	300	42	9	2½	3	7—4		3—10		4,400
8×12	32	250	48	9	3	3	8—4		3—10		4,800
9×9	40	340	40	9	2½	3	7—6		4—		4,900
9×10	44	335	44	10	3	4	7—10		4—		5,200
9×11	48	310	44	10	3	4	8—8		4—4		5,425
9×12	48	300	48	10	3	4	8—8		4—4		5,750
10×10	53	325	48	10	3½	4	8—4		4—6		5,900
10×11	54	300	48	10½	3½	4	8—9		4—6		6,000
10×12	56	275	52	11½	3½	4	8—9		4—7		6,100
10×14	58	250	54	11½	3½	4	9—6		4—10		7,500
10×15	62	250	60	11½	3½	4	9—6		4—10		7,550
11×11	76	300	48	11	3½	4½	8—9		4—10		7,900
11×12	78	275	52	12	3½	4½	9—2		4—10		8,100
11×14	82	250	52	13	3½	4½	9—2		4—11		8,600
11×15	85	225	60	13	3½	4½	9—2		4—11		8,900
12×12	95	250	58	12½	4	4½	9—6		5—		9,700
12×14	106	240	56	13	4	4½	9—10		5—		10,000
12×16	110	240	64	13	4	4½	10—		5—6		10,275
13×12	115	250	64	13	4	5	10—		5—4		10,600
13×13	122	275	55	14	4	5	10—		5—5		11,200
13×14	130	250	60	14	4	5	10—		5—5		11,600
13×15	135	240	58	14	4	5	10—10		5—10		12,000
14×14	135	250	62	14	5	6	11—		6—		12,400
14×16	140	225	66	15	5	6	11—3		6—4		12,600
14×18	150	220	68	16	5	6	12—4		7—		13,200
15×14	145	210	66	16	5	6	12—6		7—		14,000
15×16	150	210	68	16½	5	6	12—6		7—5		15,750
16×15	160	200	68	14	5	7	12—6		7—6		16,200
16×16	168	200	70	16	5	7	12—10		7—6		17,700
16×18	178	200	74	16½	6	7	13—		7—8		18,000
16×20	185	180	76	17	6	7	13—6		8—		18,500
17×18	190	180	78	18½	6	7	13—6		8—		19,000
18×18	215	180	78	18½	6	8	13—11		8—4		20,000
18×20	235	180	78	19	6	8	14—2		8—9		22,000

case the valve pistons are both of the same length, repeat the operation at the opposite end of the chest, using the same template. If, however, as sometimes happens, the valve piston on the crank end of the chest is of a different length, a new template must be made for locating the valve on this end of the chest. Now, place the valve in the chest and connect up the valve gear to its original position.

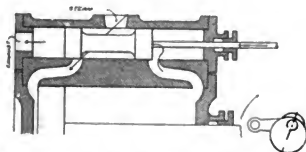


Fig. 8. Piston Valve open to the Amount of the Lead, Showing Relative Position of Crank and Eccentric.

It will be observed that the effect of admitting steam to the inside of a piston valve or between the valve pistons is the same as adding a rocker shaft to the valve gear of a slide valve engine, as the valve travel is opposite that of the piston, when the latter is at or near the dead center; therefore, after placing the crank on the dead center nearest the cylinder, turn the eccentric on the shaft in the opposite direction to that in which the engine is to run until the outer end or edge of the valve just coincides with the fine line *B* drawn on the valve seat farthest from the crank. The inner edge of that piston of the valve will then open the steam port to the amount of the lead as in Fig. 8. Fix the eccentric to the shaft and turn the crank to the opposite dead center, when the outer edge of the valve at the opposite end of the crank should coincide with the line drawn on the valve seat. If it does, then the inner edge of that piston of the valve also opens the steam port to the amount of the lead, and the valve will have been correctly set. Any difference between the leads on the two ends may be equalized by adjusting the valve stem at the guide block, and the setting of the valve should when possible be verified with the indicator.

—*The Engineer*, (Chicago), now *Power and the Engineer*, (New York).



MODERN STEAM TURBINE PRACTICE

THEORY OF OPERATION AND TURBINE CONSTRUCTION

In the economical operation of any steam motor, the fundamental principle is to utilize the expansive force of steam. The steam pump does not adhere to this principle and as a consequence is one of the most wasteful machines in existence. Full steam pressure is admitted from the beginning to the end of the stroke and motion is imparted to the piston simply by the static pressure of the steam.

Up to the point of cutoff, the action taking place in the cylinder of an automatic engine is just the same as that in the steam pump, the piston being pushed forward by the static pressure back of it in the boiler. After cutoff, however, the steam is allowed to expand and the piston is pushed forward as a result of the heat energy in the steam encased in the cylinder.

In the steam turbine, the process is the same as in the automatic engine with the exception that the flow of steam is continuous instead of intermittent. The steam is continuously forced into the nozzles of the turbine by the pressure at the inlet and during the passage through expands continuously because of the internal energy. Each particle in expanding pushes the particles ahead of it forward at a faster rate, thus increasing the velocity of flow.



Fig. 1. Illustrating the Forces of Impact and Reaction.

Though different in outward form the turbine and steam engine are equivalent in their thermodynamic action. As expressed by Lester G. French in his book on Steam Turbines, the difference in form of a turbine and engine is due to the fact that the turbine is designed to operate by changing the motion of flowing steam on the principle of the water turbine, while the engine is designed to operate by the direct pressure of the steam. The turbine is a velocity motor and the steam engine a pressure motor.

In the turbine, the steam is directed against the moving vanes by means of suitable nozzles causing the turbine wheel to rotate as a result of the impulse and reaction of the impinging jet. As generally defined, impulse is a force acting in a forward direction and a reaction is the equal and opposite force. As an illustration of these forces, refer to Fig. 1. At A a jet of water is impinging on a flat plate and the force tending to push the plate away is entirely due to the impulse of the jet. When the surface upon which the jet impinges is so arranged that the water is turned backward from the surface, the force acting on plate B is greater than that of A and increases the greater the amount of backward inclination. When a complete reversal of the original direction of the jet is obtained as at C, the force exerted on the plate is practically twice as great as at A, due to the combined effect of impulse and reaction.

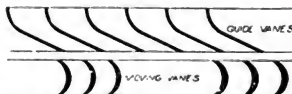


Fig. 2. Shape of Moving Vanes and Guides in Impulse Wheel.

Thus in a general way turbines are divided into two classes and are known as impulse or reaction turbines, according to the method in which the steam imparts its energy to the revolving element. This classification, however, is somewhat misleading, as all practical turbines operate both by the impulse and reaction of the steam to a greater or less extent. The real distinction between the two types is that in the impulse wheel the expansion of the steam is complete within the nozzle and in the reaction wheel it is not completed until it enters the wheel passage.

As the expansion of the steam in the impulse turbine is completed within the nozzle, there is no expansion in passing through the wheel passages, so that the pressure of steam between the vanes is the same as the pressure within the casing in which the wheel runs. The moving element of the turbine is thus

driven ahead, first by the pressure due to the impulse of the steam and then after the direction of flow has been reversed by the reaction of the steam.

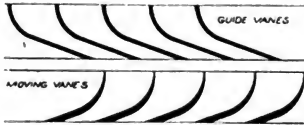


Fig. 3. Shape of Vanes and Guides in Reaction Wheel.

In the reaction turbine the expansion of steam in the nozzle is only partial, so that in the turbine wheel the steam expands still more and acquires additional velocity, thus reacting upon the wheel when it leaves the vanes as a result of the energy acquired in the wheel itself, this feature giving it the name of a reaction wheel.

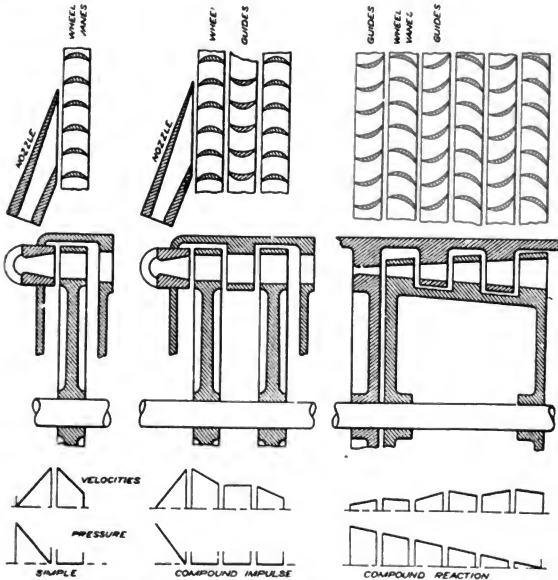


Fig. 4. Simple, Compound Impulse and Compound Reaction Types of Turbines.

In Fig. 2 are illustrated the guide vanes and moving vanes of an impulse turbine, and the same of a reaction turbine is shown in Fig. 3. These drawings in a general way illustrate the design of the two types of turbine. How the

vanes are actually constructed and their arrangement with respect to the stationary elements will be illustrated more fully in the descriptions to follow.

The two general classes of turbines, impulse and reaction, may be again subdivided into simple and compound turbines. In a simple turbine the steam from the nozzle is directed against the vanes of a single wheel. It is often desirable, however, to avoid such high speed of rotation as would be obtained with this design and also to do away with the reducing gears. This is accomplished by using several wheels, alternating with stationary guides as shown in Fig. 4. With this arrangement only part of the energy from the steam is imparted to each wheel and a much lower speed is attained.

In addition, some compound turbines are divided into stages, that is, two or more groups of wheels and guides are arranged in separate compartments, each group is called a stage, and the number of stages in any turbine will depend upon the subdivision made. With this arrangement the reduction in velocity and pressure is not as great in one stage as in any single-stage turbine.

In regard to the advantages of the steam turbine, those usually claimed are about as follows: Small floor space, close speed regulation and freedom from vibration, high economy under variable loads, water of condensation free from oil, adapted for high superheat, small cost for maintenance and attendance and little danger from water retained in the steam.

—*The Engineer* (Chicago), now *Power and the Engineer*, (New York).



GRATE AREAS FOR WATER-TUBE BOILERS

By T. F. J. MAGUIRE

In order to obtain good results, the furnace for any given boiler must be capable of burning the fuel in an efficient manner, and in addition, it must have sufficient capacity to develop the required output of the boiler. With solid fuels, the most important feature of the furnace is the extent of grate area to be employed for any given installation.

A boiler and its furnace are apt to be considered as a single piece of apparatus, when as a matter of fact they are entirely distinct and have different functions to perform. If a boiler is well designed, it will give satisfaction within the limits of its capacity, under the most diverse conditions of operation. The function of the boiler is to transfer the heat contained in the hot gases passing over its heating surface to the water contained by it, generating steam and thus creating energy in a usable form. The heating surface must be consistent with the capacity for which the boiler is built, and so arranged with respect to the path of the hot gases passing through the boiler setting as to absorb as much heat as possible from the gases before they escape from the setting. In addition, the boiler must provide for a free liberation of the steam and an efficient circulation of the water. Any standard boiler satisfying the above requirements is practically satisfactory for any plant, without modification in its features of design.

In the case of the furnace, however, the case is entirely different; and it might be stated that for the attainment of best results, each particular installation requires a furnace specially designed to satisfy the local conditions. The function of the furnace is to convert the potential heat of the fuel into heat contained in the gases of combustion given off by the furnace, and to generate this heat at the highest practicable temperature. Not only must the furnace

be capable of making this heat conversion efficiently, but it must have sufficient capacity to drive the boiler at the required maximum output. The proper furnace to employ is determined by the fuel that is to be used, and by the output at which the boiler is to work. A perfect furnace would transform all the heat in the fuel into heat contained in the gases given off by it, delivering these gases at the highest possible temperature. In the perfect furnace the rate of feed of the fuel would vary with the boiler out-put, the air supply would be just sufficient to burn the combustible matter of the fuel completely, there would be no fuel lost in the ash, no loss due to radiation from the walls of furnace, and the furnace would automatically dispose of the ash without interfering with the process of combustion. In all practical furnaces, however, there are bound to be losses due to the inability of the furnace to respond quickly to a load variation on the boiler, to the impossibility of operating at all times without deficient or excess air, to the unavoidable presence (with solid fuels) of a certain amount of carbon in the ash, to radiation, and to the chilling effect when fires are being cleaned.

The location of the furnace with respect to the heating surface of the boiler depends upon the kind of fuel employed. The arrangement should be such as to provide a path of sufficient length for the gases before they reach the nearest heating surface, so that they may have ample time to burn completely before impinging on the heating surface. As the heating surface rapidly absorbs heat from the gases, with a consequent lowering of temperature, combustion practically ceases after impingement. For coals such as the anthracite, semi-bituminous, and Eastern bituminous, in which the combustible matter consists principally of uncombined carbon, the grate may be placed relatively near to the boiler heating surface; but for Western bituminous and lignitic coals, in which the combustible matter is largely composed of volatile hydrocarbons, it is essential, for good economy, to provide a considerable path of travel for the gases from the grate to the nearest heating surface.

The following matter applies particularly to flat, hand-fired grates, with coal as the fuel. Many of the statements, however, apply equally well to other solid fuels, and to automatic stokers.

The great area required for any given boiler depends upon the grade of fuel to be used, and upon the output at which the boiler is to be operated. It is necessary to distinguish between the normal rating of the boiler (the builder's rating) and the maximum output which the boiler will be called upon to deliver. A certain size of grate might be capable of working a boiler to its rated capacity, but might be inadequate to drive the boiler for any length of time at an appreciable overload. Practically all boilers, with their furnaces, are guaranteed by the makers to operate, for a certain time, at a certain load in excess of the rated capacity, this overload being usually between 25 and 50 per cent in excess of the rated capacity of the equipment. The length of time during which the equipment will be called upon to develop the guaranteed overload has also an important bearing upon the grate area. With the grade of fuel known, and the desired overload and its duration determined, the size of the grate area depends upon the number of pounds of fuel that can be burned per square foot of grate per hour, or upon the rate of combustion of the fuel. The rate at which a given fuel may be burned depends, in turn, upon the available furnace draft. It must not be supposed, however, that the number of pounds of fuel burned per square foot of grate per hour can be indefinitely increased by a proper increase in the furnace draft. With an excessive

furnace draft, the furnace efficiency will be comparatively low, on account of excess air, the formation of holes in the fuel bed, and the rapid accumulation of ash on the grate. An excessive furnace draft, and consequent excessive rate of combustion, are not conducive to economical operation, especially for coals that clinker or that are high in ash.

The size of the grate and the intensity of the furnace draft depend upon the grade of coal to be used, and upon the rated and maximum output of the equipment and the duration of the maximum output. If the load on the plant is such as to require the boiler and its furnace to operate for extended periods at the maximum guaranteed capacity, then the grate area should be liberal enough to maintain the boiler pressure without the use of an excessive furnace draft, as the employment of the latter gives poor operating economy. It is a difficult matter for any furnace to hold up the steam pressure if the grate area is insufficient, owing to the rapid accumulation of ash on the grate and the necessity of frequent cleaning of the fire. Too large a grate area is also detrimental, because of the comparatively thin fire that must be carried and the resulting tendency to the formation of holes in the bed of fuel. It quite often happens that boilers and furnaces are installed of a rated capacity considerably greater than the actual load they are called upon to carry, and on account of excessive grate area the operating economy is poor. The efficiency of the boiler does not vary widely with the load, and even at an overload of 100 per cent, the boiler efficiency will hold up remarkably well. The furnace efficiency, however, is very sensitive to the load, especially at extreme overloads and underloads, and therefore the rated capacity of the furnace especially (and hence the grate area) should receive the most careful consideration, with relation to the kind of load that it will be called upon to carry. In general, it may be stated that for any apparatus the best efficiency is obtained when it is operated at its rated capacity, and this is particularly true of furnaces.

It is a simple matter to work out an expression for the grate area, and also for the relation existing between the heating surface of the boiler and the grate area.

Let HP = rated horse power of boiler—the maker's rating.

let f = the overload required—that is, if an overload of 25 per cent is required, then $f = 1.25$.

let E = the evaporation from and at 212 degrees F. per pound of dry coal, or the number of pounds of water, corrected to 212 degrees F., that one pound of dry coal will evaporate at the given overload.

let R = rate of combustion of the dry coal burned per hour per square foot of grate area.

As a boiler horse-power is defined as the evaporation of 34.5 pounds of water from and at 212 degrees F., the water from and at 212 degrees F., evaporated by the boiler when developing an overload f is evidently equal to $34.5 f$ HP and the pounds of dry coal burned per hour is equal to $34.5 f$ HP divided by E . The required grate area A in square feet is therefore given by the expression

$$A = \frac{34.5 f \text{ HP}}{E R}$$

It is customary, at present, to rate water-tube boilers on the basis of 10 square feet of heating surface per boiler horse power. Thus a 400 horse-power boiler would contain 4,000 square feet of effective heating surface. For a

rated horse-power "HP" the effective heating surface of the boiler is 10 HP and ratio of heating surface to grate area is

$$\frac{E R}{3.45 f}$$

With the rated capacity of the boiler, the required overload, the evaporation from and at 212 degrees F. per pound of dry coal and the rate of combustion known, it is an easy matter to determine the proper grate area, and the relation of the latter to the heating surface of the boiler. The rated capacity of the equipment, and the required overload, are invariably determined by the prospective purchaser, while the rate of combustion of the coal, together with its evaporating ability, are usually determined by the makers of the apparatus. It is evident that for best results a knowledge of the kind of coal that is to be used is very essential. The proper evaporating ability and rate of combustion to assume for any given coal are based upon previous tests made on the coal under consideration, or upon similar coals. Coals mined in certain sections of the United States are similar enough in composition, calorific value, and evaporating ability to be classed under a single head so far as the grate areas are concerned. Below are given the grate areas for certain of these classes of coals, it being assumed, in every case, that the boilers are to develop an overload 50 per cent in excess of the rated capacity.

Eastern bituminous and semi-bituminous coals of 13,000 B.t.u. heat value per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 9 pounds of water per pound of dry coal, and the rate of combustion at 30 pounds of dry coal per square foot of grate per hour. Applying the above formulae, the grate area is equal to 19 per cent of the rated boiler horse-power and the ratio of the heating surface of the boiler to the grate area is 52 to 1. At rated capacity, the evaporation may be taken at 9.4 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area the rate of combustion would be equal to about 19 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent could be easily maintained with a grate area equal to $1/52$ of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Eastern bituminous and semi-bituminous coals of 13,500 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 9.5 pounds of water per pound of dry coal, and the rate of combustion at 30 pounds of dry coal per square foot of grate per hour. Applying the above formulae, the grate is equal to 18 per cent of the rated boiler horse-power and the ratio of the heating surface of the boiler to the grate area is 55 to 1. At rated capacity, the evaporation may be taken at 9.8 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 19.4 pounds of dry coal per square foot of grate per hour. For these coals, with the proper furnace draft, an overload of 50 per cent could easily be maintained with a grate area equal to $1/55$ of the heating surface of the boiler, with good economy at both rated capacity of the boiler and the given overload.

Western bituminous coals of 12,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 7.1 pounds of water per pound of

dry coal, and the rate of combustion at 35 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 21 per cent of the rated capacity of the boiler, and the ratio of the heating surface of the boiler to the grate area is 48 to 1. At rated capacity, the evaporation may be taken at 7.6 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 22 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may easily be maintained with a grate area equal to $1/48$ of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Western bituminous coals of 11,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 6.2 pounds of water per pound of dry coal, and the rate of combustion at 35 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 24 per cent of the rated capacity of the boiler and the ratio of the heating surface of the boiler to the grate area is 42 to 1. At rated capacity, the evaporation may be taken at 6.7 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 22 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may easily be maintained with a grate area equal to $1/42$ of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Anthracite buckwheat No. 3, of 11,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 6.6 pounds of water per pound of dry coal, and the rate of combustion at 22 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 36 per cent of the rated capacity of the boiler and the ratio of the heating surface of the boiler to the grate area is 28 to 1. At rated capacity, the evaporation may be taken at 7 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 14 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may be maintained with a grate area equal to $1/28$ of the heating surface of the boiler, with good economy at both rated capacity and the given overload.

Anthracite buckwheat No. 2 of 12,000 B.t.u. per pound of dry coal.—At an overload of 50 per cent and under good operating conditions, the evaporation from and at 212 degrees F. may be taken at 7.6 pounds of water per pound of dry coal and the rate of evaporation at 22 pounds of dry coal per square foot of grate per hour. Applying the above formulæ, the grate area is equal to 31 per cent of the rated capacity of the boiler and the ratio of the heating surface to the grate area is 32 to 1. At rated capacity, the evaporation may be taken at 8 pounds of water from and at 212 degrees F. per pound of dry coal, and with the above grate area, the rate of combustion would be equal to about 14 pounds of dry coal per square foot of grate per hour. For these coals, with proper furnace draft, an overload of 50 per cent may be maintained with a grate area equal to $1/32$ of the heating surface of the boiler, with good economy at both rated capacity and at the given overload.

The above list might be increased indefinitely to cover all solid fuels, and the examples given are simply to illustrate the method of obtaining the proper grate area for any given set of conditions.—*Engineering Magazine*, Oct., 1909.

STEEL BANDS FOR POWER TRANSMISSION

By J. P. SCHROETER

Everybody who has to do with power transmission knows that our present systems, using ropes or belts, are far from being perfect. Carefully conducted experiments in the Technische Hochschule, Charlottenburg, Germany, with steel-band transmission have turned out very successfully, so that the general introduction of this kind of transmission seems to be close at hand.

It is well known that leather belts and hemp and cotton ropes are very badly affected by atmospheric conditions. They are organic materials and, in accordance with the aim of the modern designer, should be eliminated, if possible, and replaced by inorganic materials with more uniform properties. Wire ropes are only acceptable for long-distance power transmission. We know that the slip of belts and ropes is large, that the tension must be regulated very often and that the pulleys are large, taking much space and making the whole machine heavier and more expensive. The percentage of lost power is sometimes very considerable. The steel band does not show these disadvantages. It is not influenced by atmospheric conditions, an adjustment is very seldom necessary, the slip does not exceed a maximum of .15 of 1%, the efficiency is always above 99%, and the width of the pulley is considerably decreased, diminishing the space needed and saving material.

With the steel-band transmission, the distance between the pulley axles may be decreased, even until the pulleys almost touch, making it possible to use steel-bands to replace gears. The bands show no lateral vibrations and may be used at any velocities up to the highest met with in modern practice. This transmission has been used and practically tested abroad for several months.

According to the official tests made at the Technische Hochschule, Charlottenburg, with steel-bands 23 mm. wide and 0.3 mm. thick, the useful tension per centimeter of width was 15 kg. with pulleys 1,250 mm. in diameter having a peripheral velocity of 15 m. to 30 m. per second; the useful tension was 10 kg. for pulleys 600 mm. in diameter running at a peripheral velocity of 15 m. per second. The pulleys had a thin cork cover and the tension was very carefully adjusted to the most favorable conditions. Expressed in English units, these results may be summarized as follows:

Belt width	Belt thickness	Pulley diam.	Peripheral speed	Effective pull per in. width	Effective pull per sq. in. cross section
ins.	ins.	ins.	ft. per sec.	lbs.	lbs.
.096	.0118	49.21	50 to 100	84	7,112
.096	.0118	23.62	50	56	4,742

In practice there has been transmitted, with a steel-band of the above size, 145 H.P.; and, with one 100 mm. wide, 250 H.P.

There is practically no noise either at high or low velocity, and in the tests it was impossible to find any elongation of the band. Its lightness and high tensile strength permit its use at higher velocities than are permissible with belts, and its introduction for use with generators and motors has proved very successful.

An item not generally given enough consideration in calculations is the power lost in transmission. The accompanying table gives the first cost, efficiency and operating expenses with steel-bands and belt transmission.

FIRST COST, FRICTION LOSSES AND OPERATING EXPENSES FOR STEEL-BAND TRANSMISSION OF 100 HP.

		Rope.	Leather.	Steel.
First cost	Pulleys	\$177.00	\$96.00	\$60.00
	Belting	148.00	310.00	180.00
	Total	\$325.00	\$406.00	\$240.00
Losses	Loss in per cent.	13	6	0.5
	Loss in HP	13	6	0.5
	Loss per annum in HP hours	39,000	18,000	1,500
	Money loss	\$663.00	\$306.00	\$25.05
Yearly expenses	5% interest on first cost	16.25	20.30	12.00
	10% depreciation on pulleys	17.70	9.60	6.00
	20% depreciation on belting	29.60	62.00	36.00
	Friction loss as above	663.00	306.00	25.50
	Total yearly	\$726.55	\$397.90	\$79.50

Note: Diameter of pulleys, 32.8 ft.; distance between axes, 32.8 ft.; cost per HP.-hr., 1.7 cts.; 200 r. p. m.:

[A brief description of the steel band transmission, which is manufactured by the Eloesser Kraftband Gesellschaft, Charlottenburg, Germany, was published in *Engineering News*, January 9, 1908, p. 32.—Ed.]

—*Engineering News*, October 14, 1909.



GASOLINE AND ALCOHOL MOTORS COMPARED

The United States Geological Survey, has just issued a bulletin on "Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines," by Robert M. Strong. The tests, which were under the technical direction of R. H. Fernald, engineer in charge of the producer gas section of the technologic branch, were conducted at the fuel-testing plant in St. Louis, Mo., and at Norfolk, Va. The tests dealt primarily with gasoline, forming part of the investigation of mineral fuels provided for by acts of Congress. To determine the relative economy and efficiency of gasoline it was compared with denatured alcohol. When the series of tests was started, it was found that it took from one and one-half to two times as much alcohol as gasoline to produce a given power. With special alcohol engines, entirely suited to the use of alcohol, the latter fuel has been made to do as much work, gallon for gallon, as the gasoline.

By using alcohol in an alcohol engine with a high degree of compression (about 180 pounds per square inch above atmospheric pressure—much higher than can be used for gasoline on account of pre-ignition from the high temperatures produced by compression) the fuel consumption rate in gallons per horse-power per hour can be reduced to practically the same as the rate of consumption of gasoline for a gasoline engine of the same size and speed. The indications are that this possible 1-to-1 fuel consumption, ratio by volume, for gasoline and alcohol engines, will hold true for any size or speed, if the cylinder dimensions and revolutions per minute of the two engines are the same.

The low heating value of completely denatured alcohol will average 10,500 British thermal units per pound, or 71,900 British thermal units per gallon. The low heating value of 0.71 to 0.73 specific gravity gasoline will average

19,200 British thermal units per pound, or 115,800 British thermal units per gallon. Thus the low heating value of a pound of alcohol is approximately six-tenths of the low heating value of a pound of gasoline. A pound of gasoline requires about twice the weight of air for complete combustion as a pound of alcohol.

A gasoline engine having a compression pressure of 70 pounds but otherwise as well suited to the economical use of denatured alcohol as gasoline, will, when using alcohol, have an available horse-power about ten per cent greater than when using gasoline. When the fuels for which they are designed are used to an equal advantage, the maximum available horsepower of an alcohol engine having a compression pressure of 180 pounds is about 30 per cent greater than that of a gasoline engine having a compression pressure of 70 pounds, but of the same size in respect to cylinder diameter, stroke and speed.

Alcohol diluted with water in any proportion, from denatured alcohol which contains about 10 per cent of water, to mixtures containing about as much water as denatured alcohol, can be used in gasoline and alcohol engines if they are properly equipped and adjusted.

When used in an engine having a constant degree of compression, the amount of pure alcohol required for any given load increases and the maximum available horse-power of the engine decreases with a diminution in the percentage of pure alcohol in the diluted alcohol supplied. The rate of increase and decrease respectively is such, however, that the use of 80 per cent alcohol instead of 90 per cent, or denatured alcohol, has but little effect upon the performance of the engine; so that if 80 per cent alcohol can be had for 15 per cent less cost than 90 per cent alcohol and could be sold without tax when denatured, it would be more economical to use the 80 per cent alcohol.

The relative hazard involved in the storage and handling of gasoline and denatured alcohol is of particular importance in considering their use as fuels for marine and factory engines and engines to be placed in the basements of office buildings, in coast defense fortifications, or in like places where a general fire would be likely to result from the accidental burning of the fuel stored or carried for immediate supply, or where the forming of explosive or inflammable mixtures of the fuel vapors and air in the immediate vicinity would be hazardous. It is indicated by statistics and is also the general consensus of opinion of those experienced in handling gasoline, kerosene, and alcohol that the hazard involved in the use of denatured alcohol is very much less than in the use of gasoline and possibly less than in the use of kerosene, but as yet the relative fire risk has not been definitely established. Considerable work has been done on this phase of the investigation and a series of tests that will be of assistance in determining the relative hazard involved in the use of these fuels is in progress at the testing station of the Survey in Pittsburgh.

In regard to general cleanliness, such as absence of smoke and disagreeable odors, alcohol has many advantages over gasoline or kerosene as a fuel. The exhaust from an alcohol engine is never clouded with a black or grayish smoke, as is the exhaust of a gasoline or kerosene engine when the combustion of the fuel is incomplete, and, it is seldom, if ever, clouded with a bluish smoke when a cylinder oil of too low a fire test is used or an excessive amount supplied, as is so often the case with a gasoline engine. The odors of denatured alcohol and the exhaust gases from an alcohol engine are also not likely to be as obnoxious as the odor of gasoline and its products of combustion.

Very few alcohol engines are being used in the United States at the present time, and but little has been done toward making them as adaptable as gasoline engines to the requirements of the various classes of service. Engines for stationary, marine, and traction service, automobiles, motor trucks, and motor railway cars designed especially to use denatured alcohol have, however, been tried with considerable success.

The price of denatured alcohol is greater than the price of gasoline, and the quantity of denatured alcohol consumed by an alcohol engine as ordinarily constructed and operated is, in general, relatively greater than the quantity of gasoline consumed by a gasoline engine of the same type. Considerable attention is being given to the development of processes for the manufacture of alcohol from cheap raw materials which are generally available, and it seems reasonable to expect that the price of denatured alcohol will eventually become as low or lower than the price of gasoline, especially if the price of gasoline advances. It also seems reasonable to expect a greater general improvement in alcohol engines than in gasoline engines.

When used as a fuel, denatured alcohol is not always so classed as to be exempt from restrictions placed on the use of gasoline by the rules of insurance and transportation companies or city ordinances. The restrictions that are placed on the use of denatured alcohol are, however, never greater than those placed on the use of gasoline. In some places, they are such that the use of an alcohol engine is permitted where the use of a gasoline engine is prohibited. For instance, alcohol motor trucks and automobiles are admitted to many steamer piers that are not open to gasoline machines.

When the restrictions placed upon the use of denatured alcohol are less than those placed on the use of gasoline or where safety and cleanliness are important requisites, the advantages to be gained by the use of alcohol engines in place of gasoline engines may be such as to overbalance a considerable increase in fuel expense, especially if the cost of a fuel is but a small portion of the total expense involved, as is often the case. Denatured alcohol will, however, probably not be used for power purposes to any great extent until its price and the price of gasoline become equal and the equality of gasoline and alcohol engines in respect to ability to service required and quantity of fuel consumed per brake horse-power, which has been demonstrated to be possible, becomes more generally realized.

A further general development in the design and construction of engines that use kerosene, or cheaper distillates, and the crude petroleum may be reasonably expected and may delay the extensive use of denatured alcohol for some time to come, but as yet comparatively few data pertaining to this phase of the general investigation are available.—*Machinery*, December, 1909.



REPORT OF THE NAVAL BUREAU OF ORDNANCE

We learn from the report of Rear Admiral Mason, Chief of the Naval Bureau of Ordnance, that the tests of the new 12-inch 50-caliber gun showed it to be fully equal to any gun of that caliber thus far proposed for any navy. In the proving ground tests it developed an initial velocity of 3,030 feet per second and a muzzle energy of 52,500 tons. This is the gun that will be mounted on our two largest *Dreadnought's*, the *Arkansas* and *Wyoming*, which will carry twelve guns of this pattern. More powerful than this, however,

will be the new 14-inch type gun, which will pass through its tests before the end of the present year. It is designed to fire a 1,400-pound projectile with a velocity of 2,600 feet per second and a muzzle energy of 65,600 tons.

It is gratifying to learn that our present nitrocellulose powder has been developed to a point which leaves little room for improvement. Moreover, a new pattern of projectile is now being built, carrying the long pointed head that has been found to give such good results in small arms, which has shown a considerable increase in range, flatness of trajectory, danger space, striking velocity, and penetration at the longer ranges. Our older guns have been modernized, and this work has included the relining and strengthening of the 12-inch guns of our battleships of a date prior to, and including, the *Virginia* class.

The Bureau is much gratified at the remarkable results which have been obtained in target practice with equipment which was designed many years before the present principles and demands of target practice had been developed; and a new system of sighting mechanism has been worked out, and is being applied to all turret guns. Our latest ships are being fitted with complete refrigerating plants for the cooling of the magazines, and the magazines of the older ships are to be similarly fitted as opportunity offers. Changes have been made in the rotation bands of projectiles, which will considerably prolong the accuracy life of the projectiles after the gun has been so much worn that its accuracy with the older bands would have been much impaired.

—*Scientific American*, December 25, 1909.



THE ARMY ORDNANCE REPORT

In his Annual Report, Gen. Crozier, Chief of Ordnance, U. S. A., speaking of the occasional failures of heavy guns, states that the trouble arises, not from a defect in the design of the guns, but from concealed defects in the forgings or the development of thermal or heat cracks. The danger arises from imperfections lying within the finished dimensions of the forgings, which are not apparent on the surface, and cannot be detected even by the most thorough inspection. These heat cracks are due to the high temperature of the powder gases, and they increase in depth and number as the number of rounds fired increases. By way of remedy, the Department has decided to reline the guns as soon as these thermal cracks have become very pronounced. Henceforth all seacoast guns of 6-inch caliber or over, except mortars, will be provided with double tubes, so that, should the inner tube give way, the damage will not extend to the outer tube and the enveloping jacket and hoops. This will permit the restoration at small cost of guns whose tubes give way, and will facilitate the rehabilitation of guns whose accuracy has been lost through erosion and wear of the bore.

The six 6-inch and four 14-inch guns authorized by Congress at its last session will be of the wire-wound type and will have these double tubes and in the 14-inch guns the caliber length will be raised from 34 calibers, as in the guns now under construction, to 40 calibers. Within the next few months the Department hopes to test the new 34-caliber 14-inch wire-wound gun and one of the new 12-inch wire-wound mortars.

The construction of hand grenades for our army marks the reintroduction of an ancient form of weapon. They were used with good effect, we believe,

in the Russo-Japanese war. The grenade can be thrown by hand a distance of about 100 feet from a standing position. Lieut.-Col. Babbitt has designed a rifle-shrapnel grenade to be fired from the musket carried by the infantry. Troops will be furnished with both the hand and rifle-shrapnel grenades in a reasonable quantity whenever there is a call for them.

Another item of interest gleaned from the report is that Gen. Crozier is of the opinion that the government can now manufacture cheaper than it can buy; that is, if everything is taken into account except the manufacturers' profit. As an instance of this, he quotes the fact that the 3-inch field gun, which under contract costs \$2,029.80, can be manufactured at the arsenals for \$1,276.90; and that the 12-inch disappearing carriages, which cost under contract \$1,568.47, cost only \$605.35 when built at the arsenals.

—*Scientific American*, December 25, 1909



SEA STRENGTH OF PRINCIPAL NAVAL POWERS

Toward the close of each year our Navy Department, through its Office of Naval Intelligence, issues a comparative table showing the warship tonnage of the principal naval powers. It is based on the number and displacement of warships built and building of 1,000 or more tons, and of torpedo craft of more than 50 tons. The statement of the present year, which shows the relative standing of the navies on November 1st, possesses special interest because it gives an authoritative statement as to the present strength of the navies in ships of the *Dreadnought* type—a subject regarding which the public has been treated during the past few months to overmuch literature of a sensational and misleading character.

Of battleships of the *Dreadnought* type, Great Britain has afloat and completed four, Germany two, and the United States two. France, Japan, Russia, Italy, and Austria have not as yet completed a ship of the *Dreadnought* type. Of *Dreadnoughts* under construction, Great Britain possesses seven, Germany six, the United States four, Japan two, Russia four, and Italy one. France and Austria have no *Dreadnoughts* under construction. In this connection it should be mentioned that our Navy Department does not consider that a battleship is entitled to be reckoned as of the *Dreadnought* type unless her main battery consists entirely of guns 11 inches or more in caliber. This eliminates the six French battleships of the *Danton* type, carrying four 12's and twelve 9.4's, and the three Austrian battleships of the *Ferdinand* type, carrying four 12's and eight 9.4's.

Of armored cruisers of the *Invincible* type, Great Britain possesses three, and has two under construction; Germany has none completed, and three under construction; and Japan has one completed and one building. Adding together the totals for ships armed entirely with big guns, both *Dreadnoughts* and *Invincibles*, we find that Great Britain has seven completed of 125,450 tons displacement, and nine under construction of 191,000 tons; Germany has two completed of 36,000 tons, and nine under construction of 183,000 tons; the United States has two completed of 32,000 tons, and four under construction of 83,460 tons; Japan has built one of 14,600 tons and is building three of 56,200 tons total displacement; Russia has none completed and is building four of 92,000 tons total displacement; Italy has none completed, and one of 18,600

tons under construction; France and Austria have nothing either afloat or on the stocks of the all-big-gun type.

Of battleships of the first class, other than *Dreadnoughts* (in which enumeration the Navy Department includes all battleships of about 10,000 tons displacement or over that are less than twenty years old, unless they have been reconstructed and re-armed since 1900) Great Britain possesses forty-nine of 714,750 tons displacement; Germany, twenty-four of 282,424 tons; the United States, twenty-five of 334,146 tons; France, seventeen of 215,270 tons; Japan, twelve of 171,898 tons; Russia, five of 166,000 tons; Italy, ten of 122,600 tons; and Austria, three of 31,800 tons. Great Britain, Germany, the United States and Italy are building no battleships of this class, but France has six, Japan one, Russia four, and Austria three under construction.

Of armored cruisers other than the *Invincible* type, Great Britain possesses thirty-five of 416,600 tons displacement; Germany, nine of 86,693 tons; the United States, twelve of 157,445 tons; France, twenty-one of 192,982 tons; Japan, eleven of 180,900 tons; Russia, seven of 70,200 tons; Italy, eight of 59,000 tons; and Austria, three of 18,800 tons.

In the class of torpedo-boat destroyers, Great Britain leads with 148, followed by Russia with 97, Germany with 79, Japan with 56, France with 56, the United States with 17, Italy with 17, and Austria with 6. Great Britain has 20 torpedo boat destroyers under construction, the United States 19, Germany 18, France 16, Japan 3, and Austria 6.

The following table gives the relative order of warship tonnage both at present and when all the ships now under construction are completed. It will be noted that the only change in relative standing in the second list is that Germany will take the second position at present held by the United States.

Nation.	At present, tonnage.	With all vessels Completed, tonnage.
Great Britain	1,758,350	2,005,873
United States	682,785	785,687
Germany	609,700	820,692
France	602,920	766,906
Japan	396,368	489,704
Russia	259,263	412,250
Italy	216,038	257,818
Austria	114,897	167,297

Referring to the statistics of total displacement, particularly of battleships of the pre-*Dreadnought* type, we wish to draw attention to the fact that although Germany possesses only one battleship less than the United States, the average displacement of the German ships is very much smaller, being about 11,770 tons as against 13,370 for the United States battleships. Furthermore, our strength in this class of vessel is incomparably stronger, since every one of these twenty-five ships carries a main battery of four guns of 12 or 13-inch caliber, whereas ten of the German battleships carry nothing heavier than a 9.4-inch gun, a weapon which at the great ranges of 7,000 to 9,000 yards at which modern battles will be fought would be altogether ineffective against battleship armor. Hence, as late as a year ago, when Germany had no *Dreadnoughts* afloat, she actually possessed only fourteen battleships capable of fighting effectively at modern ranges, as against twenty-five flying the United States flag, and forty-nine under that of great Britain.

It is here that the careful observer of naval development must look for an explanation of the feverish haste with which Germany is building a fleet of

Dreadnoughts. The short-sighted policy which led to the mounting of the 9.4-inch gun as the principal arm in her first two squadrons of battleships, left her navy in a very serious condition when the absolute superiority of the 12-inch gun was demonstrated in the battle of the Sea of Japan. Her present lavish expenditure on battleships must be regarded rather in the light of an effort to retrieve a disastrous error than as a distinct challenge to the supremacy of the British or any other navy.

Nor is it any answer to this view of the case to state, as has so often been done of late, that the construction of the first *Dreadnought* robbed all existing battleships of their right to be named as such. We confidently predict that the battleships of the older class will play an unexpectedly important role in the next great war; and when two theoretically unsinkable fleets of *Dreadnoughts* have hammered each other into a state of comparative exhaustion, it will be the nation that can send in the most numerous second line of older ships, armed with a mixed battery of 12's and smaller rapid-fire pieces, that will win the day.—*Scientific American*, December 11, 1909.



THE COMMAND OF THE AIR AND ITS EFFECT ON LAND WARFARE

The altitude of some of the Continental Powers as to flying-machines for warfare, and the fact that much experimental work is being done in France and Germany, as well as in this country, justifies further consideration of the effect which aeroplanes and dirigible balloons may have on land warfare, a subject to which we referred in a recent article. The points of direct importance are as to what factors the ultimate command of the air will depend on, and what effect it will have on land warfare.

Taking the latter point first, we may probably quite disregard the idea of balloons being used to drop bombs into towns for the sake of wantonly destroying private property. It is quite true that a small amount of damage might be caused in this way, but it is not likely that it would be very great, certainly not enough to materially affect the issue of a war. Wanton destruction of private property has often been tried in warfare, but the effect has usually only been to embitter the struggle. There are, however, other and more legitimate ways in which the command of the air may probably be the deciding factor in a war. The first of these is the facility it gives for ascertaining an enemy's disposition and movements. This is of the utmost importance in war, and there is no doubt that a very large army might easily be completely paralysed by a very much smaller one if the latter could always ascertain the enemy's movements without revealing its own. In fact, in many cases the amount of superiority which the force without flying-machines would require from this cause alone would be overpowering. The position would, in fact, be the same as that of a blind man boxing against a man who could see. Besides getting information as to an enemy's movements, flying-machines may be of enormous use in war by acting on an enemy's communications. A modern army, especially of large size, is absolutely dependent on its communications for everything that makes it of any use as a fighting force. The amount of food alone which is required is very large, and, of course, without this the army cannot live, let alone fight. But besides food, huge supplies of ammunition and stores of every kind are required. The expenditure of these gets greater every year, as the material of war gets more complicated, the rate of fire greater, and the

expenditure of every kind more lavish, and without a steady stream of supplies pouring into it an army is helpless. Even in the American civil war, the Northern armies were often very much hampered by the raids of the Southern cavalry, who destroyed the railways, bridges, roads, etc., on which their supplies depended. The amount of damage which could be effected by cavalry would, however, be nothing to what could be done by flying-machines, owing to the superior speed of the latter, the fact that they can move over any sort of country, and that probably much larger weights can be carried than could be on a horse. No doubt if communications were short, they could be protected by leaving enough men on them, but this means (1) that the army could never move far from its base; (2) that a very small proportion of the total army could be at the front. There would probably be many minor ways in which flying-machines could also cause inconvenience and loss to the enemy.

One point of great importance is that the use of flying-machines will render the command of the sea of much greater importance than it has hitherto been. So far command of the sea has given no direct power of attack on land, except the power of subjecting a very narrow strip of coast to gunfire. This is practically useless, and so the direct power of attack on land is nil. It is true that command of the sea has often decided a war by interfering with trade, and so bringing about exhaustion, and this result is accentuated by the fact that such command gives the power to land troops at any point without warning—a matter of enormous importance. The use of flying-machines, in conjunction with command of the sea, will, however, increase the striking distance by the amount of the radius of action of the flying-machine. There is no reason why the latter should not, in the future, start from a ship as well as on land, and therefore the fleet would form their base of operations. Thus, supposing that the flying-machines were capable of flying 300 miles, it is obvious that they would have a striking distance of 150 miles from the coast in any direction, which might be a very serious matter for some nations whose military power is at present very great.

Obviously the way to combat flying-machines will be to build opposing flying-machines, and the command of the air will have to be fought for as has been the command of the sea. There will be fights in the air consisting of single engagements, and possibly of pitched battles between fleets of airships. What form the future fighting machine of the air will take it is impossible to forecast, and whether the navigable balloon will have any vogue, or whether the aeroplane will be universal, is doubtful. At present it appears as if the latter would be the case, owing to the aeroplane being faster, quicker at turning, harder to hit, and very much cheaper, the latter point always, of course, ensuring a numerical superiority, with the same money spent on each type of airship.

While it is not possible to see what form the future flying-machine will take, we can make some forecast as to what countries are likely to be most successful. The command of the air will depend on: (1) the men; (2) the material. Without men of nerve and skill to handle them, flying-machines will be useless for fighting or any other purpose. Again, without the flying-machines it is obvious that men cannot fly, and are therefore useless for air-fighting. The position is, in fact, exactly the same as that of command of the sea. This has depended on men of cool daring to man the ships, combined with a well-trained industrious body of civilians at home to supply the ships, ammunition, and other necessary stores. As regards the men, fighting in the air will apparently need essentially the same qualities as are required for navigating and fighting on the sea. But however good the men are, they are quite useless without material.

In the case of flying-machines, as in the case of ships, this resolves itself simply into a question of money. Those who spend the most money are in the position to get the most numerous and best-equipped ships, and will be in the same position as regards flying-machines. In the case of war in the air, as at sea, success will depend not only on plenty of material to commence with, but to supply the wastage of war, which is enormous, and gets greater and greater as the material gets more complicated and expensive. In all modern war success depends even more on the civilians at home supplying the fighting force with the various material it requires than it will on the actual fighting force itself; but at sea this is far more the case than on land, and in the air will probably be more so still.

As far as can be seen, therefore, the net result of war in the air will be to very greatly increase the offensive power of those nations which now have command of the sea, and to make the huge Continental armies of very much less value than they have been. In fact, the time may not be far distant when no numerical superiority will avail against a small well-equipped army having command of the air.—*Engineering*, December 31, 1909.



CENSUS OF DIRIGIBLES AND AEROPLANES

The well-known explorer and sportsman, the Prince Scipio Borghese, has presented to the Chamber of Deputies of Italy a tabulated statement showing the number of dirigibles and aeroplanes in existence in the world on September 30th. The former number 36; the latter, 76. In addition, 68 dirigibles are in course of construction. The number of machines first cited are divided among the different countries as follows:

	Dirigibles.	Aeroplanes.
France.....	9	27
United States.....	7	17
Germany.....	10	6
England.....	3	6
Belgium.....	1	5
Italy.....	3	2
Austria.....	..	5
Japan.....	1	3
Russia.....	2	1
Switzerland.....	..	2
Spain.....	..	2

The dirigibles are divided as follows into military and private ones:

	Military.	Private.
Germany.....	7	3
France.....	4	5
United States.....	2	5
England.....	2	1
Italy.....	1	2
Russia.....	2	..
Belgium.....	..	1
Japan.....	1	..

The census of dirigibles under construction is as follows:

	Military.	Private.
Germany.....	8	7
France.....	5	10
United States.....	4	7
England.....	4	1
Italy.....	2	3
Russia.....	4	
Japan.....	2	1
Belgium.....	1	2
Austria.....	1	2
Spain.....	2	
Switzerland.....	1	1

The number of aeroplanes which are known to exist are parceled among the different nations as follows:

France.....	27	Japan.....	3
United States.....	17	Switzerland.....	2
Germany.....	6	Italy.....	2
England.....	6	Spain.....	2
Austria.....	5	Russia.....	1
Belgium.....	5		

France, which possesses more than one-third of the aeroplanes in existence, is therefore considerably farther advanced than the other nations in this respect.—*Scientific American*, November 27, 1909.



THE DIRIGIBLE BALLOON

Notwithstanding its limitations the dirigible balloon has made very definite progress during the past year, and we are interested to observe that in his second Cantor lecture on "Aeronautics," Mr. Charles Cyril Turner prophesies that it will be used with effect in the next war. At the same time the limitations referred to are very real, and they are in no way discounted by Mr. Turner. As to the parallel which is sometimes drawn between the dirigible and the marine vessel, it is pointed out that there is a fundamental difference between a dirigible balloon and a marine vessel in that the latter floats on an element of great density in which its keel and its rudder and propellers find resistance only part of the hull and the superstructure being in the air. The balloon is completely immersed in air. It is akin to the submarine, but with far greater disabilities. What, asks the lecturer, would be the predicament of a submarine vessel in ocean currents going at from 25 to 50 miles an hour? Yet these are common velocities of the wind, especially at an altitude of 1,000 or 2,000 feet. The most rapid marine currents do not exceed 8 or 9 knots an hour. No wonder there are many who do not believe that the dirigible balloon has a future.

The dirigible has, however, already attained some noteworthy records. Mr. Turner is careful to remind us that "during the French army maneuvers this year the possibility in the case of a non-rigid balloon of landing and taking shelter from an enemy, and even, when it becomes necessary, of carrying out repairs without deflation, was demonstrated. It is well to bear in mind, too, that the Zeppelin airship has landed on ground as well as in the water for which

it was designed, and that last month four German military airships carried out aerial maneuvers together over Cologne. These and other achievements give us hope that within certain limits there are definite prospects before the dirigible balloon." We quote the following from a number of interesting points raised in this lecture.

Since the resistance of the dirigible is quadrupled when the speed is doubled, to double the speed of a balloon we must give it a motor power not twice but eight times as great. Herein lies the chief difficulty in the way of developing the dirigible balloon. To double the speed the power must be multiplied by eight, and the balloon must carry eight times the quantity of fuel. It must also have a gas-container and suspension capable of bearing the air resistance. On the other hand, the dirigible balloon navigator may often economize fuel under favorable circumstances, for, the resistance of the air being far less in proportion than reduced speed, he knows that by cutting off half the power he is only diminishing the speed by one-fifth. To halve the speed he could reduce the power to one-eighth. In effect, he will take advantage of calm weather and favorable wind when he is not fighting adverse conditions. It is very necessary that the balloon should keep its shape. If it gets partially deflated, the pressure of the air will put it out of shape, and it will offer enormously greater resistance and become unmanageable. Partial deflation comes from a variety of causes. One is the slow filtration of some of the gas through the fabric. Another cause is the difference of temperature and pressure at different altitudes. * * * The problems before the dirigible balloon concern strength, stability, and equilibrium. Powerful engines can be taken up—that is only a question of lifting power, and the size of the balloon; but if the balloon is driven against the air beyond a certain speed it will not bear the strain.

One often hears it remarked that a dirigible balloon can "tack" after the manner of a sailing vessel. Now it is impossible for a dirigible balloon to tack. If its independent speed be less than the speed of the adverse wind it has nothing to gain by attempting an oblique course and tacking. That would not prevent its being driven away. If its speed exceeds that of the adverse wind even slightly, it has nothing to gain by tacking. Its best course is to head straight for the goal, and make what progress it can. Coming to the limitations of the dirigible balloon due to the currents of the atmosphere, in the first place it is necessary to remember that with increasing altitude, as a rule, the velocity of the wind increases. The general rule is that for every 1,000 feet of ascent we can put on 2 miles per hour to the velocity of the wind. But this is only the average. Sometimes, especially in anti-cyclonic conditions, the velocity is unchanged and even decreases. On the majority of days, however, it increases.

With any dirigible balloon at present in existence there is only a proportion of the days of the year when progress could be made against the wind, so strong are the air currents at any distance above the earth's surface. Assuming that an airship has an effective speed of 30 miles an hour, its progress will be more than neutralized by an adverse current of the quite common velocity, at 1,000 feet altitude, of 31 or 32 miles per hour. Further, on occasions when, as is very common an air-current is favorable to an airship's proposed journey, the question of returning to the harbor must be considered. * * * One can imagine that in war an airship might find itself in a dilemma. If it descends to within 2,000 feet of the earth it is within easy range. If it ascends above it is at the mercy of a wind strong enough to blow it, despite its utmost exertion, to the enemy's lines. Dirigible balloons do not ascend to such great altitudes as do spherical balloons. Seldom, indeed, do they ascend higher than 4,000

to 4,500 feet. Great altitudes can only be obtained by the sacrifice of ballast, or by permitting great expansion and consequent waste of gas. The necessity to keep the gas in a dirigible balloon, as equitable as possible, therefore, makes high ascents undesirable. In flight, by the way, they are always losing weight owing to the consumption of fuel.

Lieut.-Colonel Moedebeck, the celebrated German expert, in his "Pocket Book of Aeronautics," as long ago as 1906, worked out the directions in which an airship can travel under varying conditions. Where the wind-speed is greater than the independent speed of the vessel, no point in the teeth of the wind, of course, can be reached, since the ship is driven back in each moment a greater distance than it can move forward. Where the speed of the wind and the independent velocity of the vessel are equal, the ship can attain to practically any part of the half-circle opposite to the point from which the wind is blowing. In the case where the independent velocity of the airship exceeds that of the wind, any point within the complete circle of 360 degrees can be attained, those with the wind from behind at a speed equal to the combined speed of wind and vessel, those against the wind at the vessel's speed less that of wind's velocity. This, at any rate, is approximately true.

The danger of landing a dirigible balloon in high wind will be great until we have some proper form of harbor. Signals from below will be necessary, since one cannot always estimate the speed of the wind. Naturally, if the aeronaut is in view of the earth and knows the distances, we can tell by his deviation from the straight course how fast he is sweeping away. But there will be many occasions when this knowledge is unattainable. As to the dirigible balloon of the future, we can assume that it will improve in general quality and efficiency, but one cannot contemplate any great increase in size. Dr. Hele-Shaw points out that an aerial *Mauretania*, with its 2,000 odd passengers, 68,000 horse-power, and 32,000 tons of weight, would require a balloon of Zeppelin's shape a mile long and with a diameter of about twice the height of St. Paul's Cathedral. Fortunately there are uses for the dirigible balloon that do not depend upon its being able to carry 2,000 people. The whole of this lecture is worthy of careful perusal. It will be found in the current issue of the *Journal of the Royal Society of Arts*.—*Page's Weekly*, January 7, 1910.

Short Notes.

A Useful Aeroplane.—Mr. Latham's flight on Tuesday must certainly be regarded as a red letter achievement. Having an appointment at a shooting party at Berru, 30 kilometers from his monoplane shed at Chalons Camp, he proceeded thither in his Antoinette monoplane, carrying his gun as easily as if the journey had been made by motor car, train, or any other means of transit. The return was also made in this manner, the results of the day's shooting being carried on the monoplane. Such an achievement would have been thought impossible of accomplishment even twelve months ago, but the indications are that before another twelve months are past it will have become a common occurrence. Tuesday's flight at any rate marks an epoch in the application of the aeroplane to the needs of transport and travel. When an aviator can unpremeditatedly use his machine to travel to any given point and return at will, the universal use of the aeroplane for light aerial transport is only a matter of time, especially with such speedy, handy, and cheap machines as the "Antoinette."—*Army and Navy Gazette*, November 27, 1909.

The German dirigible Gross III., which is described as the most powerful semi-rigid airship yet built, has carried out successful maneuvers over Berlin, the trial flight being of one hour's duration. A speed of more than sixteen meters a second, or nearly sixty kilometers an hour is reported.

—*Page's Weekly*, January 7, 1910.

New Dirigibles for France.—Some particulars are now available of the French rigid airship, which its inventor is building for the French Government. This will be the first dirigible of its kind constructed or employed in France, and, as a rival of the Zeppelin, its behavior will be closely followed. M. Spiess claims to have invented the first rigid airship in 1875, and the vessel now in preparation will be a development of his original plans. The spindle-shaped frame-work will be of specially light wood, and over this will be stretched the outer covering of rubberized cotton. Within the hull will be ten independent balloons, eight of them cylindrical and two conical so as to fit at each end. The total length of the envelope will be 290 feet, and two engines of 120 horsepower each will be employed to drive the four wooden propellers. These will be placed in line with the main axis of the vessel, and will thus give a high degree of efficiency. Indeed, so effective is the whole propelling apparatus expected to be that M. Spiess estimates that he will easily surpass the present speed records attained by dirigibles. He believes that his ship will be able to reach a speed of 45 miles an hour, and by this means he will have a vessel which can be used much more frequently than the slower ships now in commission. The French military authorities are providing a special shed in which the new dirigible will be built up, and the actual work of assembling and erecting the vessel will take about eight months.—*Page's Weekly*, January 14, 1910.

Airships.—The progress made in this branch of military science is too extensive to be dealt with in the present article. It is considered in Germany that the most serviceable military machine will be a small dirigible, of about 6000 meters capacity, on the semi-rigid or rigid system, with wood framework. Airship engines are now lightened by the use of forged instead of cast metal: thus the latest models exhibited at Frankfort had forged steel cylinders only 2 mm. thick. The type with radial cylinders revolving about a fixed crank shaft is attracting much attention, as these engines cool themselves and require no water to be carried.—*The Engineer*, January 7, 1910.

The Russki Invalid gives an account of Captain Julianin's labors in photography, or taking photographs from balloons and kites. The camera is conveyed up the cord of a flying kite by the wind acting on a small sail, and by an ingenious contrivance it is always kept horizontal. On its carrier is an aneroid to measure the altitude with means of setting it at the required height: there is also a small electric battery. The camera being ready, the sail is unfurled, the carrier going up the cord. When the needle hand of the aneroid reaches the height set at, the electric circuit closes, and upon this the camera automatically takes the photograph, the sail shuts up, and the carrier descends the cord by its own weight. Half an hour only is necessary for taking the photograph and ascertaining the distance, while the error is estimated to be not more than two and a half per cent. Kites are more suitable than balloons for taking these photographs, especially in the vicinity of the enemy's bullets. The whole apparatus can be carried on a two-wheeled cart. Its mobility, lightness, safety and accuracy should guarantee a wide use of it in the future.

—*United Service Gazette*, December 2, 1909.

A New Microphone.—According to La Lumiere Electrique, a new microphone has been constructed by Messrs. Carl Egner and J. Kannar, of Molmstrom, Sweden, which will withstand a current of ten to fifteen amperes. The details of the instrument are not given out, owing to the fact that it has not yet been protected by patents. The Swedish government recently connected several telephone lines, forming a line nearly nineteen hundred miles long, and the microphone transmitted speech very clearly over this circuit, whereas with the ordinary apparatus no audible sounds were produced. The new transmitter is being used in the Poulsen wireless telephone system, and it is claimed that conversation has been carried on over a distance of 175 miles, using a high-frequency current of six amperes.

Scientific American, January 15, 1910.

Silico-manganese and silico-chrome in medium carbons have had considerable popularity abroad for springs and for gears for motor cars. They are also made in low carbons. Chrome steels in high carbons are much used for balls and ball races. Tungsten steels of special analysis are universally used for making magneto magnets.—*The Engineer*, December 31, 1909.

Wireless Telegraphy and Telephony.—Although no very sensational development has occurred either in wireless telegraphy or telephony during the past year, yet there has been very appreciable advance in both. It will be remembered that public attention was forcibly directed to the value and utility of wireless communication between passenger steamers by the circumstances connected with the loss of the *Republic* in January of last year. A wireless general call for assistance from the heavily injured *Republic* was detected by the *Baltic*, then some 70 miles to the westward, which vessel succeeded in reaching the *Republic* and saving the passengers and crew, numbering in all some 1600 persons, before the injured vessel sank in deep water. There would probably have been much loss of life if the *Republic* had not been equipped wirelessly. This event has had a marked effect upon the use of wireless telegraphy by ocean passenger ships. Nearly all the large Atlantic liners have been equipped with the apparatus. Out of 282 steamships of all kinds carrying steerage passengers to or from the United States during the first half of 1909, 143 are stated to have been wirelessly equipped, while of 167 prominent coastwise vessels, 97 were so equipped. In the navy records there are now nearly 1000 specified wireless telegraph shore stations or equipped vessels, exclusive of numerous warships.

In receiving instruments or wave-detectors, solid rectifiers have come into very extended use during the year. In fact, it is now common to use two such receivers, one of perikon, for long-distance most sensitive work, and the other, say, of carborundum, of lesser sensitiveness, but greater stability for shorter range communication. Progress has also been announced in the direction of high-speed reception of wireless messages by the use of a string galvanometer and a photographic apparatus, whereby the rapid oscillations of the "string" enables the message to be recorded photographically on a moving strip of paper. In sending apparatus, improvement has been made both in oscillation frequency and in group frequency. As regards oscillation frequency, sustained oscillations have been successfully used at 75,000 or 100,000 cycles per second, both by means of specially designed alternators and of arc devices, whereby the sending antenna has been kept in full sustained oscillation instead of being allowed to give separate free

oscillations by spark discharge. This has either greatly increased the radiation power, or has reduced the power needed to be supplied to an antenna in order to reach a distant station. As regards group frequency, when free oscillations or spark discharges are used, a distinct improvement has recently been made by exciting the antenna with a step-up transformer from a 500-cycle, alternator-current circuit, instead of from the usual 60-cycle circuit. The groups of oscillation-trains forming the signals then give rise to sounds in the receiving telephone having a pitch of 500 cycles per second, to which the ear is much more acute than when the group-frequency is only 60 cycles per second. This increases the sensitiveness of the receiving system, and the range at which signals can be detected.

—*Electrical World*, January 6, 1910.

Portable Wireless Outfit Receives Without Aerial.—A recent newspaper report from New York states that a remarkable demonstration was made on January 9 last in the editorial rooms of the *New York World* by E. N. Pickerell, manager of the Waldorf-Astoria wireless station.

It is stated that Mr. Pickerell, has proved by a series of experiments during several years past, that the high aerial is not a necessary adjunct of a wireless receiving station. To prove his theory to the *World* editors, he connected up his apparatus, which was contained in a leather receptacle of small size, to a typewriter, and used for a "ground" a near-by steam radiator.

The test prescribed by one of the *World* editors was the receiving of a pre-determined message, unknown previously to the demonstrator, from the offices of the wireless company at 42 Broadway, which was successfully done.

"Almost anything will do," Mr. Pickerell declared. "At home I use the frame of my bed. Out of doors I use an umbrella hanging over my arm. I purpose putting a coil in my hat and affixing the telephone receivers so that they will hardly be noticeable, and I will get messages just as effectively as if I had the highest priced apparatus in the world. In warfare all a detachment needs to do is to send up a kite with a fine aluminum wire in place of string, and with the portable apparatus the men would always be under the general's command."

Asked over how great a distance he had tested his new receiver, Mr. Pickerell said he had spoken through it with Vera Cruz, Mexico, and Colon, Panama, both more than 2,000 miles away, and as to obstructions, he had messages from Colorado Springs to Cripple Creek, which had the great Pike's peak, 14,147 feet high, between them.

—*Electrical Review and Western Electrician*, January 15, 1910.

Electric Growth in 1909.—*The storage battery.*—In the storage-battery art improvement continues satisfactorily, both with respect to the elements and the auxiliaries. The most marked improvement in recent years, is the permanizing or impregnating of the negative plate, which process was independently and almost coincidentally developed by inventors connected with three of the leading storage-battery companies. Planted negative plates lose capacity in the course of time and prior to the advent of the permanizing process it was necessary to make the elements with an excess capacity in the negatives, this surplus being often as high as 100 per cent. In spite of this high initial capacity, the output of negatives tended to decrease, and in some cases plates within two years would be unable to supply their rated discharge, and within three or four years had to be replaced. One process consists simply in soaking a plate in some

solution of a solid, which may be carbonized, such as sugar. After the pores of the active material are filled with the solution, the plate is heated until the sugar is carbonized and the pores are thereby prevented from clogging or closing up. The capacity, therefore, remains constant, and so far as can now be determined, the life of the negatives so treated is indefinitely long. Curiously enough, an old negative plate so treated regains and maintains its capacity. The use of pasted electrodes diminishes with the passage of time, and now that the pasted negative plate is becoming no longer necessary to maintain the cell capacity, it is threatened with extinction. The greatest factor which has limited the use of storage batteries has been the initial cost and the high annual charges for depreciation and maintenance. During the past two years prices have been materially lowered and the life of the negative plate indefinitely prolonged, so that the interest, maintenance and depreciation have all been greatly reduced. A broader field for the application of batteries is thus opened and the number and size of battery installations will undoubtedly increase.

Electrical World, January 6, 1910.

Telephone Statistics.—H. Vop Hellrigl.—An article giving several interesting statistical tables on telephone statistics in the world. The statistics bring out chiefly the enormous advances which have been made in the use

	Telephones in 1909	Length of lines in km.	No. of telephone conversations per year
United States	6,600,000	22,300,000	11,373,000,000
All other countries	2,900,000	11,800,000	5,633,000,000
Europe	2,500,000	10,400,000	5,013,000,000
American, except United States ...	300,000	800,000	138,000,000
Asia	100,000	300,000	313,000,000
Australia	70,000	300,000	158,000,000
Africa	7,000	10,000	11,000,000

of the telephone in the United States compared with that of all other countries. The chief figures are summarized in the foregoing table. Of the European countries Germany is first, with 880,000 telephones in 1909, England second with 590,000, and France third with 197,000.—[*Elek. und Masch.* (Vienna), December 12, 1909].—*Electrical World*, January 6, 1910.

The Japanese Army in 1908.—*Coast artillery material.*—At the present moment the armament of the coast defenses is rather miscellaneous. It comprises mortars of 9, 15, and 24 centimeters; howitzers of 9, 10.5, 12, 15, and 28 centimeters, and guns of 9, 10.5, 12, 15, 19, 24, and 27 centimeters; some from Creusot, some from Krupp's works, and others made at Osaka. It has been decided, however, that eventually guns of three calibers only are to be employed. These will be: a O.F. 15-cm. (6-inch) gun; a gun of 27-cm. (10.63-inch); and a 12-inch gun (305-mm.). All these guns will have a length of 45 calibers, and will be protected by armor plating. As a general rule the Japanese prefer disappearing mounts to armored turrets, which are very costly and require delicate handling.

—*Journal of the Royal United Service Institution*, November, 1909.

Ammunition.—Attempts to construct a universal projectile which shall be efficient as either a shrapnel or a high explosive shell are still proceeding. The best shell of this nature is the Ehrhardt shrapnel, with a high explosive

charge in the head and with the bullets packed in trinitrotoluol. A large number of these shells has been ordered by the German Government. Trinitrotoluol, the new high explosive, is safe, powerful, and has excellent keeping qualities, but is sluggish and difficult to detonate without a strong fulminate primer, which is dangerous to use. Krupp's claim to have overcome the difficulty by their system of progressive detonation. The flash from the fuze is communicated to a primer of nitro-glycerine powder enclosed in a stout steel cylinder. By the time this bursts, the temperature and pressure within it rise high enough to partially detonate the central exploder, which completely detonates the main bursting charge. Trinitrotoluol is now much used as an ingredient of ammonal, which is employed by several nations as a burster for high explosive shell.—*The Engineer*, January 7, 1910.

A "Tracer" Bullet.—Rumor has it that a bullet has been devised by the Austro-Hungarian authorities which gives the same trajectory as does the one in ordinary use, but differs from it in being filled with a smoke-generating substance which, in the course of its flight, gives off a slight mist, and consequently enables the path of the trajectory to be accurately followed. The idea is doubtless copied from that embodied in the design of the projectile destined to be used in an attack on balloons, which, by thus indicating its path, enables corrections to be accurately made for succeeding rounds. If the same principle can be successfully applied to infantry fire, it is obvious that it will be of extreme value, as at present it is only under favorable conditions of light, soil, etc., that the fall of bullets can be observed. Any device to remedy this state of things would not only increase the efficiency of infantry fire, but would tend to the saving of a large quantity of ammunition which is at present thrown away. No doubt, if the report proves to be correct, our own authorities will institute trials of their own, the results of which will be followed with interest.—*Army and Navy Gazette*, December 11, 1909.

Length of Ships and Gun Power.—The extreme length, about 700 feet, of the new battleship-cruiser *Lion*, recently laid down at Devonport, is being used by the designers, apparently, to mount an extra pair of primary guns. Whether these primary weapons will be 12-inch guns, or the late 13.5-inch type of ordnance, remains to be seen. Probably the 12-inch gun of fifty calibers will be used, as this is a very powerful weapon, and ten 13.5-inch guns would require a ship of larger displacement than the *Lion*, great as is her predominance in that respect over her immediate predecessor, the battleship-cruiser *Indefatigable*. It is not only the extra weight of guns and mountings that has to be considered, but there is likewise a large additional weight of ammunition to further submerge the hull, and displacement is increased very rapidly by these and other additions necessary for large guns. Then it is also probable that the *Lion* will carry a battery of 6-inch guns, for secondary and anti-torpedo purposes, which will add a large amount of top weight. But ten 12-inch guns is a very formidable armament for a cruiser, and makes her the equal of a *Dreadnought*, so far as dealing out lusty blows is concerned, although her armor will not protect her from return blows so well as a *Dreadnought's*. It will be interesting to note if the *Dreadnought's* disposition of primary guns will be followed, or if the great length of the *Lion* will be used for a different disposition of the turrets, so as to increase the broadside fire. In this new ship length was necessary to boiler power and speed, and this length is to be used to increase the gun power of the vessel.—*United Service Gazette*, December 23, 1909.

Armoring the Sides of Destroyers.—A matter of great importance in torpedo warfare has been engaging the attention of the officials at Whitehall for several years past, but as yet no final decision appears to have been arrived at. It is that of protecting torpedo craft with side and deck armor. Innumerable experiments have been carried out, and old vessels which have been "caste from the torpedo flotillas have been tricked out with armored plates and towed away to suitable ranges and pounded by quick-firing guns of the smaller caliber. But the problem as to whether abnormal speed is not a better protection than armor plates for this kind of craft is still with us; each plan having its advocates with their set of more or less plausible and practical arguments. A rapidly moving object is certainly very difficult to hit, even when it is lighted up by the beams of powerful searchlights. A slower moving vessel would be more readily hit by the gunlayers; and as four-inch guns are now being used for anti-torpedo armaments, and six-inch weapons will be introduced in the near future, it would require very thick and heavy armor plates to keep the projectiles of the guns from finding the vitals of small vessels of this description. But heavy armor plates mean stouter built ships, and weight means less speed. On the whole, therefore, it is unlikely that we shall see torpedo craft covered with side and deck armor, in part or in whole, and this conclusion finds favor with most of those naval men whose opinions have great weight in such matters.

—*United Service Gazette*, December 9, 1909.

"Stopping" Torpedo Craft.—As the searchlights at present being used in the fleet are not sufficiently powerful to discover hostile torpedo craft, at a distance which will bring them under fire before they enter the danger zone of Whitehead torpedoes of the latest pattern, a new problem has arisen for the gunnery and torpedo experts to solve. Experiments have for some time been going forward in which "Star" shells are used to light up an enemy's position at long range. So far this means of illumination has not proved to be entirely satisfactory, although a large measure of success has been gained. We understand, however, that a new series of experiments with the object of illuminating the position of torpedo boats or flotillas by night is shortly to be resumed, and the authorities are said to be sanguine as to a good result being obtained. It is also a matter of great concern to gunnery men to find out a projectile that can be effectually used against torpedo craft from the guns which form the primary armaments of battleships. To fire armor-piercing projectiles or common shell against torpedo boats from 12-inch guns, at long range, is to impose a duty upon turret gunlayers which is not likely to bear good fruit. What is needed is a suitable shrapnel shell, but with this class of shell it is difficult to have the walls of the shell thick enough to stand the external pressure of a cordite charge sufficiently large to carry the projectile a long distance, and at the same time sufficiently thin to be easily ruptured by a small bursting charge which it is necessary to place inside the shell itself, and arrange for it to explode when the shell has reached the object it has been fired at. In this matter, however, progress is likewise being made.—*United Service Gazette*, December 9, 1909.

A Ship's Compass.—One of the problems in submarine navigation is the installation of a satisfactory compass. In all submarines now building a 7-inch compass has been installed in the superstructure, while a 6½-inch compass has been installed on the portable bridge for surface navigation. With this change in size of compasses and taking into consideration the increased size of the boats, it is believed that the compass installation of submarines will prove

satisfactory. Experiments with gyroscopic compasses have been carried on for some years in foreign navies with but little success. The Auschutz gyroscope would seem from recent news reports to be the best so far obtained, and the naval attache at Berlin has been instructed to investigate and report on this Auschutz instrument at Kiel, Germany. In considering the gyroscopic compass it has always been held that the mechanical difficulties were too great to be overcome—that is, for providing a satisfactory compass for universal use. If, however, instead of trying to supplant the magnetic compass by the gyro, we merely supplement it, using the magnetic compass for cruising, etc., and the gyro for battle conditions, it is believed that such an arrangement would be very desirable. At its best the magnetic compass would not be very reliable during an action, owing to the changing magnetic conditions of the ship due to gun fire and injuries sustained. If a gyro can be obtained which is accurate within a degree for a period of two or three hours, the probable length of a battle, it would probably prove sufficiently accurate for all purposes, and, as the gyro would be used only during battle exercise or battle, the mechanical requirement would not be difficult to meet.

—*Army and Navy Register*, December 25, 1909

The Argentine Navy.—The final plans of the new Argentine *Dreadnoughts* have now been passed. The ships will be called *Rivadavia* and *Moreno*. They will be of 25,000 tons displacement, and carry twelve 12-inch, twelve 6-inch, and twelve 4-inch. The speed will be 22 knots. There will, it is said, be two funnels and two skeleton masts of the new American type. The whole of the twelve big guns will bear on either broadside. The contract is to contain a clause for the completion of the ships in eighteen months.

Orders have also been placed for twelve ocean-going destroyers of the same programme. These will be of about 900 tons and 32 knots speed. The contract for four has been placed in this country, four others in France and four in Germany. The contract for this country has been secured by Messrs. Cammell Laird.—*The Engineer*, December 31, 1909.

H.M.S. Invincible.—H.M.S. *Invincible*, after many delays due to defects in the electric turret gear, is to be ready for sea in a few weeks, or practically nine months after first commissioning, during which time the main armament has never been fit for service.

This vessel has been the subject of many parliamentary questions, which have been unsatisfactory both from the point of view of the questions (which have been drafted to infer blame attributable to the contractors), and the answers, which have endeavored to disguise the experimental nature of the electrical turret gear.

Through the difficulties have now been thought to be overcome, it is practically certain that the experiment of electrically-worked turrets is a comparative failure, the increased speed of working as against hydraulic gear which was anticipated not having been realized.

It seems fairly certain that we shall not yet see a system superior to the hydraulic for actuating our heavy guns on board ship.

—*The Engineer*, November 19, 1909.

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible, by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

Fort Monroe, Va., February 5, 1910.

The Editor,
Journal U. S. Artillery.

Sir:—

My attention has been called to the fact that it would appear from a casual reading of an article on "Attack of Warships" which appeared over my signature in the JOURNAL for November-December, 1909, that the effect of the gyrostatic action, due to axial rotation, on the striking angle of a projectile, *was stated as a fact*. As a *matter of fact* the theory was mentioned, simply to emphasize the improbability of obtaining favorable angles for the perforation of armor at battle ranges and under battle conditions and to explain just what the theory of gyrostatic action was, it being constantly referred to by many distinguished writers on armor attack.

A careful reading of pages 224, 225, and the footnote on page 226 will indicate that the views of the two authorities quoted, were accepted with a reservation. An effort is being made to collect data concerning experiments having to do with the theory of gyrostatic action and its effect, which will be submitted to you for publication in a future number of the JOURNAL.

Very Respectfully,

JOHN W. GULICK,

Captain, Coast Artillery Corps.

BOOK REVIEWS

The Relations of the United States with Spain. By Rear-Admiral F. E. Chadwick, U. S. Navy. octavo, 610 pages. \$4.00 net, post-paid \$4.40. Charles Scribners Sons, New York.

A splendid book, ably written, and deserving of much careful study. For the author has accomplished a task, which will be appreciated by the reading public, namely: a judicious condensation of all the causes which led up to the Spanish War, and a careful and much needed glimpse into the diplomatic correspondence between this country and Spain for the 135 years prior to the war.

The book reveals the most thorough preparation, and lacks the padding so usual in modern historical works. There is a comprehensive grasp of the subject and a sympathy displayed for the Spanish people as delicate as that of Washington Irving for the same nation. Everywhere however the reader knows that the writer is dealing with facts, and cannot but admire when the author with a candor which spares not, deals justice to both nations alike.

Admiral Chadwick, in a most thoughtful chapter shows us, that the real antagonism between the nations started not merely in the Cuban question or the Floridas, but in the deeper struggle between the semi-Oriental and Saxon races. The United States was Anglo-Saxon in the origin and therefore essentially practical, unconventional and radical, also protestant in ignoring the ways of the past. The Spanish nation, on the contrary, was the offspring of the races of the Mediterranean world and therefore antagonistic in all ways of thought and action to a people it naturally considered an upstart, whose ancestors were uncouth barbarians, when Spain had possessed for about a thousand years all the art, literature, law and splendor of an ancient world.

Between the Spanish older civilization and the North American Anglo-Saxon there existed therefore the most divergent racial unlikeness, which could only result in conflict, and which proved true in the war of 1898.

The book also shows that the modern Spaniard is the outcome of races, of which the two predominating types are the Semitic and the Saracen; with all the courtesy, poetry, grace of these two types and unfortunately the vices, cruelty, fanaticism as well revealed in the individuals and national life of Spain. Where you find the Jew and the Saracen, there you expect and do find religious enthusiasm, bravery, greed, and these are Spanish traits also. But the greatest weakness of both Jew and Saracen is in the utter lack of the gift of administration, and herein lay the cause of the decline of the Spanish empire. The Spanish nation left an impression on the new world, as Rome did on the ancient, but failed to maintain its grasp of power by any executive display. As one of Spain's own authors writes upon this subject—Don Pablo de Alzold, quoting Don Fernando de Silvela, "*Revista Contemporanea*" V., III., (1898): "If some day a mature judgement of our decadence and fall is written, there will be placed first of all these causes—the evident inferiority of our aptitude for administration and government."

A certain Oriental method of dealing in a most indirect and dilatory manner with great crisis in the nation's history, combined with the lack of administrative power in the race, prepared the way for the downfall of one of the greatest nations, with the greatest opportunities of any in the world's remembrance.

Another point the writer calls to our attention in order to explain the cause of so much misunderstanding between the nations, is the utter inability of Spain to understand the democratic movements and thought of the nineteenth century. Because all the democratic spirit that did arise in Spain as a result of the age, was stifled by France and the Holy Alliance. For the the French invasion of 1823 meant the total suppression of the liberal movement thought and Constitution, and rent Spain with anarchy and strife, from which it has not yet recovered, and also fastened on Cuba and the Spanish colonies the despotic régime of the king's decree of 1825.

Again to quote this idea of the writer, France, Russia, Austria, and Prussia were the culpable partners in a crime which fastened woe on the Spanish people and kept alive their evil elements. "Were it not for them, Cuba today might have been a Spanish Canada, and the Philippines a Spanish India." To the Holy Alliance are due the prevalence of anarchy in Spain, the misunderstandings and bitterness toward the United States and the loss of Spain's colonial empires.

In dealing with our relations as leading up to the war, it states that the seeds of discontent were sown in the Peace of 1763 at the conclusion of the French and Indian War; as springing into blade and leaf as soon as the United States became a nation; as developing vigor during the discussions regarding the Floridas, Louisiana, and New Orleans during 50 years; as budding during the next 75 years; and as bursting into noxious bloom during the Grant and Cleveland administrations and ripening to the decay of bitter war in the McKinley administration.

The book clearly shows the importance of the parts played by France, Napoleon, England and the Vatican in the course of events leading up to the War, and states with clearness how frequently the good offices of both France and England delayed for a time the impending crisis.

One is surprised on reading the book to find out the really weak character of President Jefferson as displayed in the diplomatic correspondence regarding the Louisiana claims, and it probably would be well for the nation if more of the diplomatic letters of the Presidents were printed for the public perusal, so that we might understand better some of the present problems, and judge the men concerned more correctly.

We read with pride however, the chapters dealing with the Cleveland administration, where that President and Richard Olney rise, for the time at least masters of the Spanish situation.

Full justice is also done by the author without fear or favor to the Congressional discussions of 1897 and 1898. When the noble actions of a patriotic President, McKinley, and a loyal Congress bring forth the praises of that day, and will for years to come demand respect.

Ten years have broadened and mellowed the study of this historian, Admiral Chadwick, so that no vain prejudice or jingoism are apparent in any sentence. And ten years ought to have sharpened our desire to know the secret history of the War, as such ability as his can reveal it. No scholar, statesman, nor officer can afford to deprive himself of the instruction and pleasure gained by reading this work, one of the ablest books of the decade.

by Admiral Chadwick, the historian of a war and its problems, which have done so much to broaden the scope of our national horizon.

To place emphatic stress upon the leading idea brought forth by the writer, the following quotation will have the clearness of direct thought and expression, "The war was the final act in the struggle for supremacy between the Anglo-Saxon and men of the Latin race in North America, in which Philip, Elizabeth, Drake, Howard, Chatham, Vernon, Wolfe, Montcalm, Washington had, all, a part. * * * It was the end of a race struggle which had lasted full three hundred years." And quoting the book again, "The Spanish dominion in America, in which there had been much both of glory and of shame, with splendid episodes of heroic endeavor, noble self-abnegation, and great attainment, was to end in the final sacrifice, nobly met, in the sea which had through generations witnessed so many conflicts of the two races."

And we conclude with those eloquent words of Admiral Chadwick, which show the broad scope and sympathy of the writer, so that others may desire the closer study of the work.—"Though Spain was to lose her American dominion, she was not to lose the good-will and kindly regard of the American people, linked as these are to her by the chain wrought by the great discoverer, and to whom Spain must ever be the land which has made so much of the history of the Western world."

The Rifle in War. By Captain Henry E. Eames, 10th U. S. Infantry. U. S. Cavalry Association, Fort Leavenworth, Kans. 8½ x 5¼. 331 pp. 63 il. 1909. \$2.00.

This is a book in six chapters, in which the subject of rifle firing is treated from a scientific standpoint. It handles the subject in a novel way and is probably the first time such a work has appeared in the English language.

Chapter I deals with "Elementary Principles"; Chapter II, with "Computations"; Chapter III, with "Effect of Fire"; Chapter IV, with "The Fire Fight"; Chapter V, with "Problems in Fire Direction"; and Chapter VI, with "Instructional Methods".

The author begins with first principles and leads up through mathematical deductions to his conclusions, some of which seem rather startling and difficult to agree with, because, as he himself says, "he has made many long leaps from the statement of the problem to the calculated result". Nevertheless, after careful study, the reader is bound to admit that most of his deductions and conclusions are sound.

The book should be especially interesting to the artillerist because it demonstrated that infantry fire should be handled along the same lines as artillery fire—that the same principles apply to both, and that the effect of the fire of each can be compared by the same method—the method which he gives in great detail in Chapters II and III.

The author points out as a result of his deductions that heretofore entirely too much time and attention has been wasted on individual rifle fire beyond five or six hundred yards and that the time so wasted should have been devoted to collective fire under battle conditions. He is undoubtedly sound in this conclusion, although all military men will hardly admit that all long range individual practice should be abolished.

The "Problems in Fire Direction" are unique and instructive and illustrate in a simple and convincing manner what the author has deduced theoretically.

Any infantry or cavalry commander has it in his power to test the accu-

racy of any statement in the book with which he does not agree, and it would probably result in great good to the service, in addition to changing some preconceived ideas, if these tests were made.

On the whole, the book is worthy of careful study, especially by infantry and cavalry officers. Even if the ideas advanced therein are not accepted, the reader will probably be started on a new train of thought on the very important subject of rifle fire, which will help him individually and may lead to important results to the service at large.

The author is to be commended for his painstaking research and labor in his effort to give the service a modern and scientific work.

The senior instructor of tactics at the Service Schools, in commenting on the book, says: "The department has been handicapped for want of a proper book in English on the rifle, but I believe this has now been obviated by Capt. Eames, 10th Infantry, in his book, 'The Rifle in War.' It supplies a need of the schools and one of our entire army."

The Russo-Japanese War. The Battle of Liao-Yan. Prepared in the Historical Section of the German General Staff. Authorized translation by Karl von Donat. Late Lieutenant, 33rd (East Prussian) Fusilier Regiment, German Army. XVI+221 pp. 6 x 8. Cloth with ten appendices and ten maps. London: Hugh Rees, Ltd., 119 Pall Mall, S. W. 1909. 10/6 net.

This, the third volume of the Russo-Japanese series, is perhaps the most important of all the set since it deals with the crucial test of the relative strengths of Russia and Japan in Manchuria. It was here that the Russian tendency to retreat was positively developed beyond question and here that the Russian morale received a shock from which it never entirely recovered. Hence the military reader looks with special interest to this volume. The arrangement of the text is admirable and permits the reader to follow with ease each situation as it develops. Marginal notes refer to the proper map to accompany that portion of the text. The comments at the end show a mastery of the situation and results indicating a careful and scholarly weighing of the merits of the two commanders, judged by their works. The type is clear and the maps up to the usual standard of excellence. This book should be found in the library of every student of military history.

The Provisioning of the Modern Army in the Field. By Henry G. Sharpe, Brig. General, U. S. Army. Franklin-Hudson Publishing Company, Kansas City, Mo. 6 x 9. 98 p. 4 il. 1909.

As an introduction to his treatise the writer, by reference to the expressed opinion of various commanders and military writers illustrates the great importance of a proper consideration of the subsistence of troops in the field. The difficulties involved and the problems connected therewith are clearly presented with the idea of inducing a "greater number of thoughtful men to devise measures to overcome them and thus ameliorate the sufferings and horrors of war."

The necessity for the adoption of definite plans for provisioning the army along with plans for the mobilization and concentration of troops is first commented upon. The accumulation of supplies at various depots near the base of operations during a period of preparation, the character of these supplies and the amounts thereof, are then discussed under suitable headings.

This is followed by remarks emphasizing the importance of establishing

proper lines of communication by which depots may be kept stocked, troops furnished provisions and supplies pushed forward as the lines advance. The writer proceeds to demonstrate that these are problems which particularly affect the transportation facilities of an army and hence require serious consideration.

He argues that plans should be adopted such that the amount of transportation required may be reduced to a minimum and in order to accomplish this, that a day's rations should always be carried by the troops themselves, troop trains with additional supplies should follow within half a day's march and supply trains to replenish them should be within a two day's march.

As the troops continue to advance a series of depots will have to be established along the lines of communication, the farthest to the front, known as the advance depot being not more than a two day's march from the troops.

It is then shown how the furnishing of supplies during an advance can be greatly assisted by the use of railroads and automobiles and the stocking of an advance depot facilitated by obtaining supplies from the inhabitants within the theater of operations. In connection with this latter consideration the writer believes a plan of campaign should be governed by statistical data gathered in time of peace concerning the resources of the districts to be traversed.

This data should relate to all matters affecting supplies and the procuring thereof whether by purchase, requisition or foraging.

The different features of the above methods of obtaining supplies are then discussed together with the importance of requiring subsistence officers to have a thorough knowledge of each and the ability to apply any one to prevailing conditions.

The article is concluded by remarks upon the relative values of fresh and canned meat, on the importance of providing for a supply of fresh bread and in the proper work incident to the issue of rations.

In an interesting appendix the author has added notes compiled from various sources on expeditions beyond the sea, embarkation and disembarkation for wars, the transportation required in front of an advance depot and the disadvantage of using cattle on the hoof for providing fresh meat.

The notes on expeditions beyond the sea is of particular interest and aims to emphasize the importance of preparations in time of peace for embarkation, voyages, disembarkation and subsequent operations ashore.

Methods used by the United States in its war with Spain are then contrasted with those used by Japan in its operations against the Russians in Manchuria.

In this connection the observation is made that "the immunity from disaster, which has hitherto attended our arms may, and probably will, fail us at a critical moment if the object lesson of Japanese foresight and Russian supineness be not taken to heart."

Elements of Military Hygiene. Especially arranged for officers and men of the line. By P. M. Ashburn, Medical Corps, U. S. Army. Boston: Houghton Mifflin Company. 5 x 7½. 314 p. Price \$2.00.

The writer of this small book has succeeded in presenting the essentials of the subject in a manner which should appeal strongly to all interested in the care of troops. The general plan and arrangement are excellent.

Beginning with the considerations which should govern in the selection of the recruit, the conditions which influence his health in garrison and in the

field are then treated of in a most thorough and practical way, the chapter on "Hygiene of the Barracks" being an admirable one. A discussion of the causes of disease follows under the headings of "Remote or Predisposing Causes," "Immediate or Exiting Causes" and "Disease Carriers". This arrangement helps the reader to a full understanding of the importance of carriers in the spread of disease.

In Part III the defenses against disease are considered. The natural defenses of the body are described and the theory of immunity explained. Then follows a description of the other means of defense,—the maintenance of the natural resistance of the body, avoidance of the sick, ventilation, isolation, quarantine, sanitary engineering, disinfection, and drugs. In the remaining chapters interesting descriptions of the infectious diseases are given. The book has already been adopted as the text-book for use in garrison and service schools of the army.

Notices

THE AMERICAN EXPOSITION IN BERLIN, 1910

This Exposition will be unique in many ways. Its exhibits will be entirely American, and its object will be to acquaint the people of Europe and especially of Germany, with the nature and extent of the industries of the United States. Our exports to Europe in 1908 amounted to \$1,270,016,773, of which \$274,178,712 went to Germany. It is thought that these figures will be materially increased thru the knowledge of our products which will be given by this Exposition to the people of Europe and of the world in general. It will be held in the exposition Palace, which was built for such purposes in 1907, and is located in the heart of Berlin. It will open in June and close in August, thus covering the most beautiful time of year in Germany, as well as that when tourists from all over the world flock to that country by thousands.

The following paragraphs are from the letter sent out by the managing committee:

"That America is to have a comprehensive and representative Exposition in Berlin in 1910 is assured. Manufacturers and business men throughout the country are displaying a lively interest in the undertaking and applications for space have been received by the American Committee from many states. The indications are that every branch of American progress will be shown at the Exposition.

The prospectus points out the practical side of the Exposition as follows:

"As this will be the first All-American Exposition ever held in a foreign country, it will be of interest to all Europe as well as to America. Expositions have not been overdone there as they have here. American enterprise is well recognized abroad and the rapid progress of this country has attracted the attention of the entire world. Thus, an American Exposition, held in the heart of Europe, will be of inestimable value to the manufacturer and business man in that it will give him an opportunity to show and to demonstrate to a receptive audience what has been accomplished in the United States along every line of endeavor."

Any information desired may be obtained by addressing the Secretary, American Exposition (Berlin, 1910), Hudson Terminal Building, 50 Church Street, New York.

THIRD ANNUAL CEMENT SHOW, AT THE COLISEUM, CHICAGO.

The first authentic record of the use of reinforced concrete was at the World's Fair in Paris, 1855. At that time, a small row-boat, built by Mr. Lambot, about fourteen feet long and constructed of cement mortar, one-half inch thick, reinforced by wire netting, was on exhibition. This boat is still in use at Meraval, France.

Since that time the use of reinforced concrete has become so important in building operations that a national exposition of concrete and reinforced concrete products is held each year in the big Coliseum, Chicago.

The next exhibition will be held February 18-26, and it is expected that over one hundred thousand people will attend. The railroads have made reduced rates on account of the Show.

WANTED.—Copies of the January-February, 1908, issue of the JOURNAL U. S. ARTILLERY. This is now out of print. Anyone having an extra copy, or copies, will greatly oblige the Editor by sending them to him. He will gladly pay fifty cents per copy for six copies.

The article in the JOURNAL—"Armor and Ships" (July-August, 1906), has been revised and brought down to date by its author, Captain John W. Gulick, C. A. C., Instructor in the Department of Artillery and Gun Defense of the Coast Artillery School. This is now issued as a pamphlet of 136 pages, containing 101 illustrations, and can be obtained from the Journal U. S. Artillery at fifty cents per copy.

New Advertisers

We take pleasure in inviting attention to the following advertisements, appearing for the first time in this issue of the JOURNAL. We bespeak for them the consideration of our readers:

Colgate & Company, New York.

U. S. Cavalry Association, Fort Leavenworth, Kansas.



MARCH-APRIL, 1910

JOURNAL

OF THE

UNITED STATES ARTILLERY



PUBLISHED UNDER SUPERVISION OF THE SCHOOL BOARD
OF THE COAST ARTILLERY SCHOOL

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Photograph by Carl Speck.

LATEST GERMAN TURBINE TORPEDOBOAT (S. 166) MAKING 36.6 KNOTS IN HER TRIALS

JOURNAL

OF THE

UNITED STATES ARTILLERY

*"La guerre est un métier pour les ignorans
et une Science pour les habiles gens."*

VOL. 33 No. 2

MARCH—APRIL, 1910

WHOLE No. 102

ELECTRIC LIGHTING AND POWER PLANT OF THE COAST ARTILLERY SCHOOL, FORT MONROE, VA.

BY MAJOR I. N. LEWIS, COAST ARTILLERY CORPS

On the completion of the new buildings of the Coast Artillery School in 1908, the question of a school power plant of sufficient capacity to supply steam for heat and power, and current for light, power and laboratory instruction, was considered in connection with the urgent need of an electric lighting plant for the post of Fort Monroe. As a measure of economy and increased operative efficiency it was officially decided to install as a part of the equipment of the School for Enlisted Specialists, a single plant large enough to meet both needs. This plant, which has been in operation continuously since December 8, 1909, is the most complete of its kind so far installed by the Quartermaster's Department for service use, and it may also be considered to be up-to-date in all respects from either the technical, or the commercial, point of view.

The specifications as finally prepared and sent out to competing manufacturers included the following separate items :

1. The supply and erection, completely equipped with accessories, breechings and stack connections, of two, 272 H.P., water-tube boilers, and one, 100 H.P., water-tube boiler, arranged in a single battery.

2. The supply and installation, complete, of two horizontal, duplex or cross-compound, high-speed engines of 250 H.P., each, and one high-speed angle-compound engine of 120 H. P.

3. The supply and installation, complete with switch-board and instruments, reactance coils and wiring connections, of the two 150 K. W., direct-connected, direct-current, three-wire generators, and one direct-connected, direct-current, three-wire generator of 75 K. W. capacity.

4. The supply and installation of all piping and of steam and water auxiliaries for the plant, including a surface condenser with its suction and discharge connections, feed-water heater, hot well, water tank, feed pumps, injectors, oil separator, automatic relief valve to the atmosphere, steam traps and automatic trap for separator, as well as steam header and live steam supply connections.

5. The supply and installation of a complete under-ground three-wire system of conduits with lead-covered cables, for distributing current to all barracks, quarters, and other public buildings on the Fort Monroe reservation, including a complete under-ground conduit supply of current for street and other exterior lighting, and the necessary iron poles, lamps, fixtures, and connections for lighting purposes.

Contracts under these specifications were awarded in February, 1909; the actual work of construction and erection in place was begun early in March, 1909, and the completed plant was turned over to the Department of Enlisted Specialists, Coast Artillery School, for operation in December, 1909. In a future issue of the JOURNAL will be given in detail, the practical results of the operation of the plant during the months of January, February and March, 1910, showing in tabular and graphic form, the complete cost and other data of operation as recorded by the half-hourly entries in the daily log of engine and boiler rooms.

A special effort is being made to follow the best commercial practice in all that pertains to economy and efficiency of operation, although the military conditions imposed, combined with the small load factor and the rapidly fluctuating school demands for steam and current during certain parts of the twenty-four hour day, add considerably to the total cost as computed on the basis of output in kilowatt-hours for light and power.

The plant is fully equipped for operation as may be desired; condensing, non-condensing with exhaust to atmosphere and live steam used for heating buildings, or non-condensing with exhaust steam used for heating.

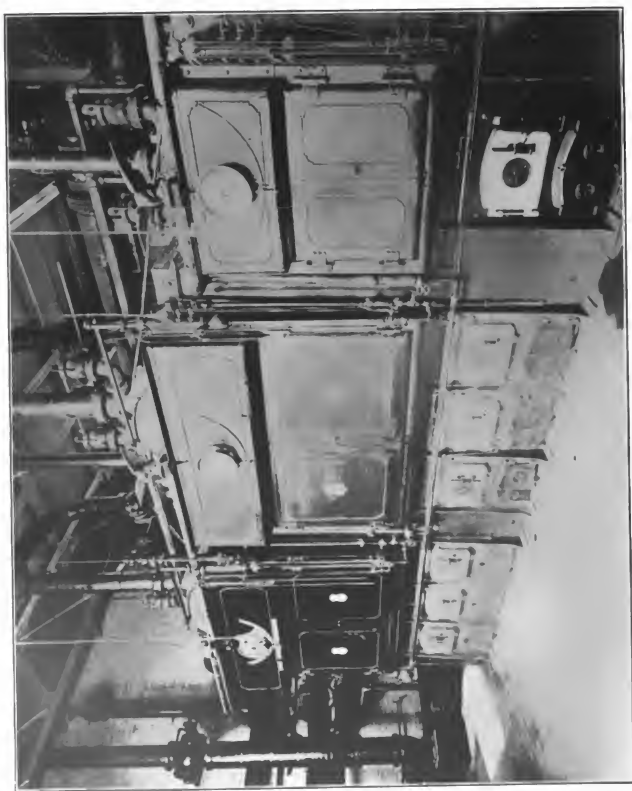
The change from one method of operation to another is easily and quickly effected without shutting down. Provision



Department of Enlisted Specialists, C. A. S.

ENLISTED SPECIALISTS BUILDING, COAST ARTILLERY SCHOOL.

POWER PLANT ON THE RIGHT.



Department of Enlisted Specialists, C. A. S.

BOILERS.

is made for supplying feed-water to the boilers as follows:— (a) direct from the street mains when not under steam, from the mains through feed-water heater and the pumps or injectors, and from the mains directly to pumps or injectors; (b) from a tank reservoir of 2,500 gallons in the boiler room to the feed-water heater, or to the pumps, or injectors, direct; (c) from the hot well, when operating condensing. These alternative means of feed-water supply are advisable when boilers are used for instruction purposes; also to guard against temporary interruptions due to accidental failures in the post water supply.

The instrumental equipment of the boiler room is more complete than is usual in a commercial plant of this size. Means are provided for taking the temperature at any time of the feed-water as it enters the boiler, and of the flue gases at up-take and at the stack; also, the quality of the steam as it leaves the steam drum.

The dampers are controlled automatically by the steam pressure, and a permanent record is kept of the draft in furnace and stack at intervals of thirty minutes. A Sarco CO₂ recorder is employed as a check upon, and aid to the firemen. Hand stoking is employed, as the size of the plant did not warrant the installation of mechanical stokers.

The personnel on regular duty in the plant includes: one master electrician, three engineers and three firemen of the Coast Artillery School Detachment, under the superintendence of an officer, 1st Lieutenant Offnere Hope, C. A. C., Instructor in the Department of Enlisted Specialists. No civilians are employed.

BOILERS AND ACCESSORIES.

The contract for furnishing the boilers and accessories called for under item 1 of the specifications was awarded the Heine Safety Boiler Company, St. Louis, Mo. The contract requirements of the completed installation, were in brief as follows:—

The two larger units to be exactly similar in all respects, and the small unit to differ from the others in capacity only; the three forming a single battery connected to the stack by suitable breechings and smoke flue. Each unit to be an all-steel, sectional water-tube boiler complete in all respects, suspended from iron columns with beam supports, bricked-in, with walls lined with fire brick, and having suitable cleaning, fire, and ash-pit doors.

The total heating surface of each large boiler is 2718 sq. ft. and of the small one 978 sq. ft., the corresponding grate surfaces being 68 sq. ft. and 28.1 sq. ft. respectively.

The open-hearth steel used in all pressure parts, except in the tubes and mud drums, has a tensile strength of from 52,000 to 62,000 pounds. The tubes are of hammered charcoal iron, and the mud drums of car-wheel mixture.

All pressure parts were completely assembled in the shop and made tight under hydraulic pressure of 270 pounds per square inch. After erection in place this test was repeated. Each boiler is capable of carrying 180 pounds working pressure with safety, although the safety valve in our daily operation is set at 125 pounds pressure.

In addition to the above tests each boiler has been carefully tested for efficiency, evaporation and capacity, under working conditions.

The fuel used is anthracite coal, egg, or nut, size.

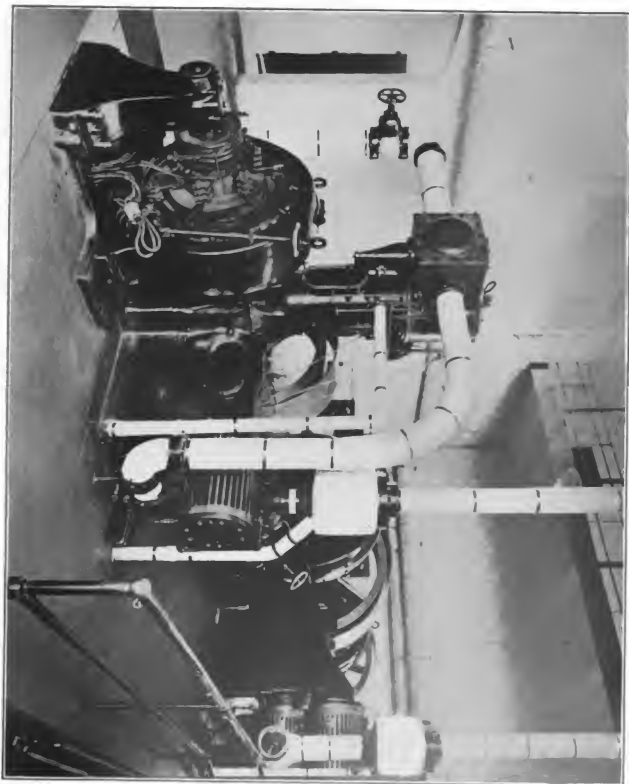
ENGINES.

The contract under item 2 of the specifications was awarded the American Engine Company, Bound Brook, N. J. and included the installation of two high-speed duplex compound engines, for regular work, of 250 horsepower, and one angle-compound engine for light-load work of 120 horsepower capacity, each fitted with extended shaft, sub-base, and outboard bearing for direct connection to three-wire direct current generators.

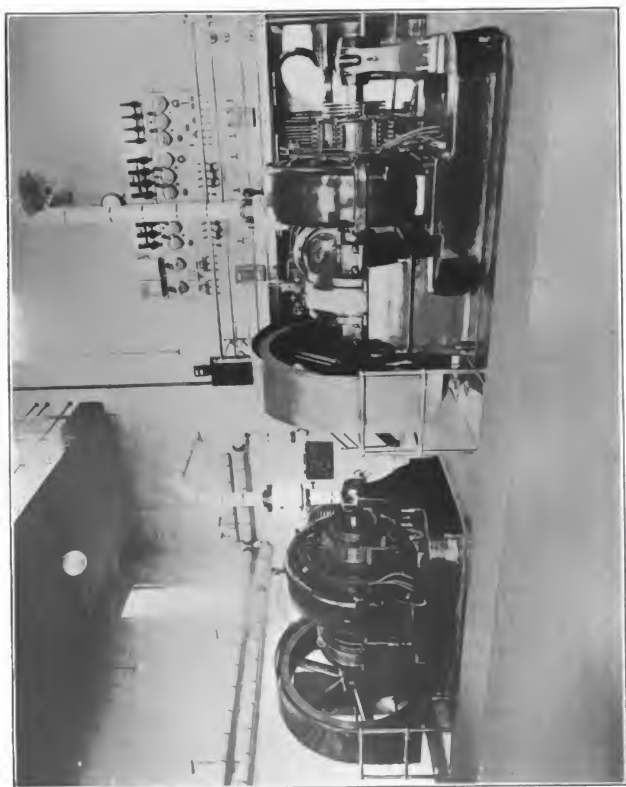
The three engines were installed on their foundations and completely equipped in place by the contractors, and were turned over ready for test with piping connections, throttle and exhaust valves, steam separators, duplicate automatic lubricators, gauges and gauge boards complete with instruments and reducing mechanism, indicators, and fittings for each engine.

As these engines are called upon to give fair service efficiency under widely fluctuating loads, when operated condensing, non-condensing with exhaust to atmosphere, or non-condensing with exhaust to heating system and a back pressure of five pounds, the rigid requirements under which they were tested and accepted, and under which they are now successfully operating may be of interest.

With a working steam pressure of 125 pounds, and a vacuum of 26 inches, each of the duplex compound units gave under test the following results condensing: Efficiencies of 76%, 83%, 90%, 94%, and 94% at $\frac{1}{4}$ load, $\frac{1}{2}$ load, $\frac{3}{4}$ load, normal load,



Department of Exalted Specialists, C. A. S.
THREE GENERATING UNITS. ANGLE COMPOUND UNIT IN FOREGROUND.



Department of Evliada Specialist, C. A. S.

TWO 150 K.W. UNITS AND SWITCHBOARD.

and $1\frac{1}{4}$ load respectively; with a steam consumption per brake horsepower of 19 lbs., 18 lbs., 17 lbs., 18 lbs., and 19 lbs., respectively, at the loads named.

Running non-condensing with a back pressure of five pounds, each engine gave, at the loads indicated above, efficiencies of 53%, 70%, 80%, 83% and 82%, and a steam consumption per developed horsepower of 42 lbs., 32 lbs., 27 lbs., 24 lbs. and 23 lbs., respectively.

A corresponding series of tests for the smaller angle-compound engine has not yet been completed on account of its continued operation 18 hours daily for school and lighting purposes, but the tests of it already made indicate equally satisfactory performance both as to efficiency and economy.

GENERATORS.

The Westinghouse Electric & Mfg. Co., Pittsburgh, Penn., were awarded the contract for supplying and installing the generators and switchboard under item 3 of the specifications.

The contract called for material and labor necessary to furnish and install two, 150-K.W., and one 75-K.W., direct-current, three-wire, compound engine-type generators completely equipped with regulating devices, switchboard and all connections, ready to supply current at 240-120 volts to the three-wire under-ground conduit system of distribution of the post.

The guaranteed rating, efficiency, operation, temperature and regulation of these machines were as follows:

Rating.—Each of the large units to develop continuously 600 amperes at 250 volts; the voltage at no load to be 240 volts; and the speed 220 revolutions per minute. The 75-K.W. unit to develop continuously 300 amperes at 250 volts, at a speed of 325 revolutions per minute; and to give 240 volts at no load.

Efficiency.—The efficiency to be based upon the iron losses in the armature, the copper losses in the brushes, armature coils, shunt and series field coils, and the friction loss at the brushes. These efficiencies to be determined separately at the rated speed, and to be as follows for each 150-K.W. unit:—

- for $\frac{1}{4}$ load at 242 volts, 87 per cent.
- for $\frac{1}{2}$ load at 245 volts, 91 “ “
- for $\frac{3}{4}$ load at 247 volts, 92 “ “
- for full load at 250 volts, 91- $\frac{1}{2}$ “ “

For the 75-K.W. unit the efficiency percentages at the loads named above to be 78%, 88%, 90%, 90%, and 89 $\frac{1}{2}$ %, respectively.

Operation:—Each machine to operate without sparking, burning the brushes, or discoloring the commutator, without change in the position of the brushes, from no load to 50% over-load, and with no injurious sparking at 75% over-load when applied temporarily. As a further test for sparking, when under over-load of 75%, the circuit breaker in the main circuit may be opened without injury to the generator.

Temperature:—The temperature tests for each generator to be the same, and the method of making these tests to be that recommended by the American Institute of Electrical Engineers.

After continuous operation at full load for twenty-four hours the temperature of no part except the commutator to be more than 35 degrees centigrade above that of the surrounding atmosphere. The allowable rise in temperature of the commutator being limited to 40 degrees centigrade. Immediately following the full load test for temperature as indicated, each machine to be run for one hour at 50% over-load, with a final rise in temperature above atmosphere of not to exceed 50 degrees centigrade; a momentary increase of load to 75% over-load causing no injury.

Regulation:—The fields of the generators to be compound-wound and so proportioned that at constant speed the voltage, will be increased by equal increments from 240 volts at no load to 250 volts at full load—the neutral connection dividing the voltage into two equal parts so that the fields receive energizing current from both legs of the circuit, with a voltage reading of 122 on each leg. One-fourth load unbalance must not show a voltage difference of more than 7 volts.

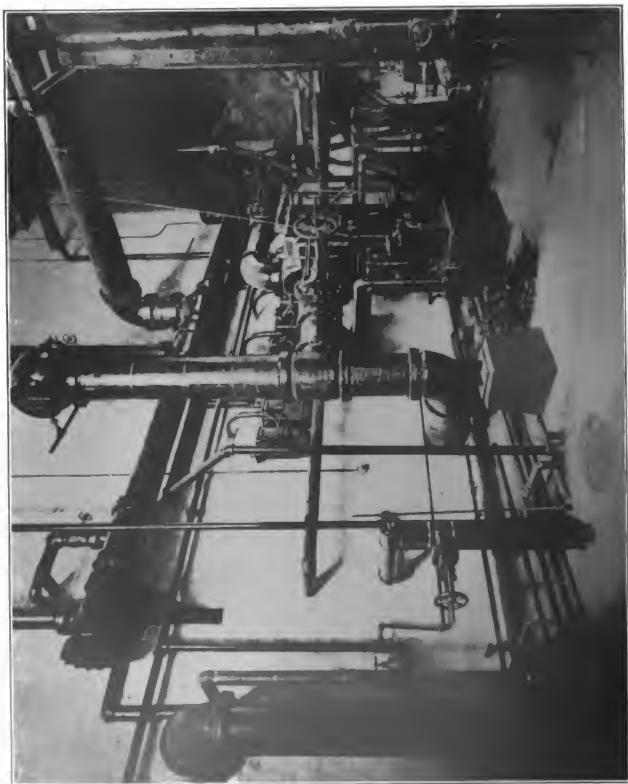
The generators were first tested in the shop, and again thoroughly tested after installation. The manufacturer's guarantees were amply fulfilled in all respects.

The switchboard as installed is completely equipped with the instruments and devices necessary for safe, economical operation. There are four panels of polished light-blue Vermont Marble, each comprising a main panel and a sub-base; one panel for each generating unit, and one for distribution and record. The distributing panel carries the following equipment: One field rheostat; one recording voltmeter, with scale 100-300 volts; one recording ammeter, scale 0-1000 amperes; two triple-pole, single-throw 800 ampere knife switches; one integrating wattmeter in glass case to measure all outgoing current; two indicating ammeters, one of 1000 amperes capacity, the other of 150 amperes capacity; also switch for lighting, fuses, lamps, etc.



Department of Entomological Specimens, C. A. S.

STORAGE BATTERY ROOM.



Department of Enlisted Specialists, C. A. S.

PIPING AND AUXILIARIES.



Department of Enlisted Specialists, C. A. S.

PULLING CABLE THROUGH CONDUIT.

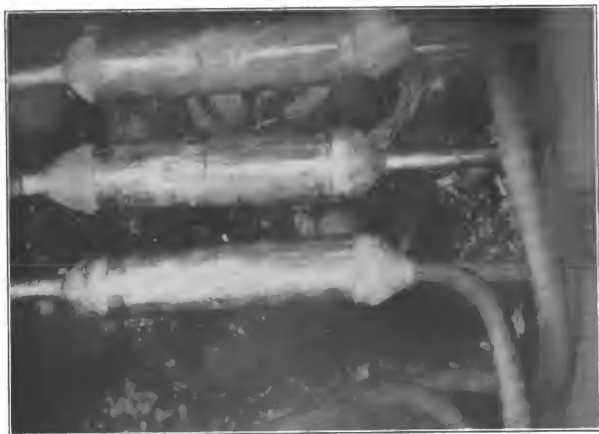


Department of Enlisted Specialists, C. A. S.

LEAD COVERED CABLE AND REEL.



Department of Enlisted Specialists, C. A. S.
STREET LAMP CONNECTION.



Department of Enlisted Specialists, C. A. S.
CABLE SPLICES IN JUNCTION BOX—VIEW FROM ABOVE.

Each of the panels for the 150 K.W. units carries: one field rheostat; one indicating voltmeter (0-300 volts); two indicating ammeters (0-900 amperes); one 4-pole, double-throw knife-switch of 900 amperes capacity; one circuit breaker capable of adjustment to open circuit as desired between 200 and 900 amperes; also lamps, fuses, etc. The panel for the 75 K.W. generating unit carries: one 4-pole, double-throw, knife-switch of 600 amperes capacity; one field rheostat, two circuit breakers capable of adjustment from 100 to 600 amperes; one indicating voltmeter (0-300 volts); two indicating ammeters (each 0-600 amperes); one integrating wattmeter to measure output of the generator; one three-pole, single-throw knife-switch to disconnect lower bus bars from outside wiring; also lamps, fuses, etc. The switchboard as a whole, is substantially mounted upon an iron platform above the level of the generators, and is provided with suitable stairway with heavy brass railings.

AUXILIARIES, PIPING, ETC.

The contract under item 4 of the specifications was awarded to the Malcolm W. Hill Company, Philadelphia, Penn. This contract included material and labor necessary to furnish and install all steam and exhaust connections of the plant, the suction and discharge connections to the condenser, one Burnham surface condenser complete; one Cochrane feed-water heater; three Dean feed pumps; three composite inspirators; one gauge board, completely equipped; one Sargent steam meter; one Davis automatic, back-pressure, atmospheric, relief valve; one oil separator and Bundy trap; a reserve water supply tank of 2,500 gallons capacity, equipped for measuring water for test purposes; a cement-lined hot well four feet in diameter and six feet deep below floor level; also all valves, fittings and extra piping necessary to make such a plant operative.

The steam piping was tested, after erection, by hydraulic pressure to 300 pounds per square inch, and the completed installation was subjected to a service test of operation before acceptance.

THE UNDERGROUND CONDUIT SYSTEM.

The firm of Crook, Kries & Co., Baltimore, Md., was awarded the contract under item 5 of the specifications for a complete underground system of current supply and distribution for the post of Fort Monroe. The firm completed the work in a satisfactory manner and was able to meet fully the rigid require-

ments of the specifications. The plan of distribution called for a net-work of underground lead-covered cables from the power station to all public buildings at the post, with the exception of those in and near the Quartermaster's corral, which latter temporarily receive current from overhead wiring pending a decision as to their permanent location. No part of the fortifications is included in the post lighting system. The cables are laid in bituminized fiber conduits supplied by the American Conduit Company. The contract included all necessary trenching and excavating for putting down the fiber conduits and embedding the same in concrete, the construction of manhole and junction box connections, the supply and pulling in of cables, the installation of main switches and distributing panels in buildings, and an independent system of cable supply for street lighting.

The cables were subjected to severe physical, chemical and electrical tests before laying, and when laid and connected, each cable was again tested and showed an insulation resistance of at least 750 megohms per mile. The completed installation comprises the following lengths and sizes of copper conductors:

1,020 feet,	750,000 c. m.
5,562 "	500,000 "
615 "	400,000 "
7,835 "	250,000 "
4,618 "	211,600 "
9,789 "	134,200 "
3,580 "	106,500 "
687 "	85,521 "
1,946 "	83,521 "
1,521 "	66,564 "
6,971 "	No. 1, B. & S.
8,841 "	No. 2, "
17,724 "	No. 4, "
30,615 "	No. 6, "

The manholes for pulling in and splicing cables are placed approximately three hundred feet apart. They are three and one half feet square and four feet deep, are built of concrete six inches thick, and are provided with double covers of cast iron fitting water tight. Wherever branch service connections are made to main feeders, a junction box is provided. These junction boxes are built of concrete five inches thick and have cast iron covers fitting water tight into iron frames set into the concrete, the joint between cover and frame having a rubber gasket. The fiber conduits end flush with the inside walls of the box. After drawing main cables through the junction box and completing and carefully testing each branch connection, openings between lead sheath and duct were packed with jute

Department of Enlisted Specialists, C. A. S.

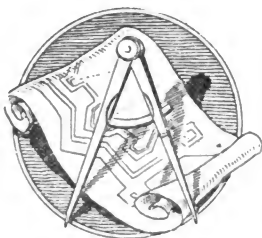
WATER FRONT, FORT MONROE, SHOWING STREET LIGHTING. 100 WATT TUNGSTENS.



and made tight, the box was partly filled with coarse dry gravel, and boiling parafine was then poured in until the box was filled, after which the cover was screwed tightly into place.

For street lighting ninety-five 100-watt tungsten lamps, in multiple, at 120 volts, are used. The iron poles which carry the lamps are of neat design, and each is set in a block of concrete 15 inches square and four feet deep. The lamp when burning hangs vertically at a distance of five feet from the body of the pole and sixteen feet above the ground. These ninety-five tungsten lamps have replaced eighty 500 watt, series, A. C., inclosed arcs formerly used; they give a better and more evenly distributed light for side-walks and roadways.

During three months of continuous operation no defect has developed in any part of the underground cable system. The voltage distribution throughout the system is very satisfactory and variations in voltage at any particular point from conditions of no load to full load seldom exceed two per cent. The three-wire generators operate efficiently under all service conditions, — even when the current demand on the two legs of the circuit is unbalanced twenty-five per cent. The plant as a whole is both efficient and economical.



A POSSIBLE USE FOR AEROPLANES IN WAR SUGGESTED BY WITNESSING THEIR FLIGHTS AT LOS ANGELES

BY CAPTAIN S. F. BOTTOMS, COAST ARTILLERY CORPS

All army officers who witnessed the recent flights of heavier than air machines at Los Angeles during the recent aviation meet at that place, seemed to be much impressed with the certainty, speed, ease, and apparent safety with which such machines could be navigated, and also the possibility of their use in time of war, for the purpose of attacking hostile forts or armies in the field by dropping upon them from a considerable height missiles containing high explosives. The French machine used there could easily carry 150 pounds of such missiles in addition to two men. The only difficulty in the way of such use appeared to be in the possibility of extreme inaccuracy in placing a missile dropped from a machine flying at sufficient height and speed to reduce to a minimum the danger to the machine from an attack made by troops, or batteries on the ground. A short test of the accuracy with which missiles could be dropped from a rapidly moving aeroplane was made by Lieutenant Paul W. Beck, Signal Corps, U. S. A., during the meet at Los Angeles. The missiles used were small bags of sand dropped from a height of about 250 feet while moving at a speed of about 40 miles per hour. The target was indicated on the ground by marking the center and corners of a square about 25 feet on a side with squares of white cardboard. While the results obtained were not very satisfactory from a standpoint of accuracy still it was evident that practice would enable an operator to drop these explosive missiles with a degree of accuracy sufficient for all practical purposes.

For this work it will be necessary to construct a suitable table by the aid of which the operator will be able to tell at what point with reference to the target the missile should be dropped. The following is suggested as being a possible route along which this art might be developed.

As the machine will be moving at a rate not less than 40 miles per hour, it will be necessary to allow the missile to leave the

flying machine at a point in advance of the object to be hit. The problem is to construct a table which will enable the operator to determine this point accurately.

Let A represent the speed of the machine in feet per second. Let B represent the time in seconds for a body to fall through the height, H. Then AB will be the distance passed over by the machine while the missile is falling through the height H and H/AB will be the natural tangent of the angle of depression of the target at the instant at which the missile should be released from the machine, neglecting for the present the retarding effect of the air

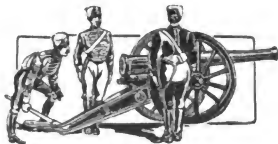
TABLE OF DEPRESSION ANGLES.

Speed M. H. F. H.		Hgt.	200	210	220	230	240	250	256	260	270	280	290	300
40	59								47°20'					
41	60								46°51'					
42	62								45°53'					
43	63								45°27'					
44	64								45°00'					
45	66								44°07'					
46	67								43°42'					
47	69								42°52'					
48	70								42°26'					
49	72								41°38'					
50	73								41°15'					

$$t = \sqrt{\frac{2H}{g}}, \quad g = 32.$$

on the missile during its fall to the target. The table required will be one which will show these angles of depression for all speeds and heights likely to be met with in practice. Such a table computed for various speeds from 40 to 50 miles per hour for a height of 256 feet is shown above. It will serve to show the method of constructing a complete table. To use this table the method proposed is as follows: Read speed from aerometer attached to

machine. Select some well defined object below and determine the time in seconds required for the machine to travel from a point where this object "bears" 45 degrees below to the point where it "bears" 90 degrees below. This time multiplied by the speed per second will give the height. (This method of finding the height will be recognized as another application of the means of finding the distance to an object on shore from a ship by taking a "four-point bearing" on the object.) With known height and speed refer to table and find corresponding angle of depression. When target "bears" this angle of depression, release missile. Except for retarding effect of the air the missile should then hit the target. This effect can be determined experimentally for various heights and speeds and from the data so obtained a corrected table can be made out. As the machine can always approach a target along a path perpendicular to the direction of the wind, the effect of the wind may be left out of consideration in constructing a table of corrected angles of depression. For determining the angles of depression of a target from the flying machine, each machine will have to be provided with a telescope properly mounted for reading vertical angles and carried on gimbals so the trunnions of the telescope can be held at all times horizontal.



ATTACK AND DEFENSE OF FORTIFIED HARBORS

BY CAPTAIN HARRISON HALL, COAST ARTILLERY CORPS

The defense of a fortified harbor presents certain problems the definite solution of which should be determined upon prior to the opening of hostilities.

The operations of an enemy within the vicinity of an artillery district will be restricted by hydrographic features existing in time of peace, as well as during hostilities and will assume one or more of the following forms of attack:—

- | | | |
|--|---|---------------|
| 1. Raid. | } | purely naval. |
| 2. Reconnaissance. | | |
| 3. Blockade. | | |
| 4. Bombardment. | | |
| 5. Direct attack, | | |
| a. On mine field and obstructions. | | |
| b. On coast batteries and accessories. | | |
| 6. Attack on land side by army combined with any of the above. | | |

1. The raid will be made probably at the opening of general hostilities, or as a preliminary to other operations in a particular locality. It will depend for success upon its suddenness and unexpectedness.

Torpedo boats will be used in the attack, their object being to disable ships in the harbor and damage docks or to destroy outlying fire control installations.

One or more boats will be used depending upon the amount of damage possible to be inflicted.

Patrol boats and searchlights should be used to detect the beginnings of such movements.

Obstructions, small caliber rapid fire guns of the defense, afloat and ashore, and torpedo boats themselves can be effectively used to defeat these attacks, but the first requisite is to perfect a service of security and information which will prevent the surprise necessary for success.

2. A reconnaissance will be made by a few swift cruisers or torpedo boats only.

Their object will be to obtain information as to the location of the elements of defense.

An approach to the harbor will be made in hopes of drawing the fire of batteries.

Such an operation may be attempted with either force in possession of the sea and will be a preliminary to later attacks or landing operations.

Mortar batteries or guns invisible from the sea may be used to inflict damage during a reconnaissance but no firing should be attempted which would give the enemy any desired information.

Such action would insure the success of the reconnaissance.

3. A blockade will not be undertaken without first establishing supremacy on the sea.

The object of the enemy will be to isolate a harbor, to interrupt or destroy commerce, to insure the safe transportation of troops, or to prepare for more active forms of attack.

A fleet of considerable strength made up of battleships and cruisers accompanied by torpedo boats and destroyers is required for the effective blockade of a well defended harbor. The blockade proper will consist of preventing the passage in or out of the harbor of any vessels not partaking in the attack.

Given the supremacy of the sea the success of an effective blockade is assured.

Blockading ships should be harassed by torpedo boats and submarines of the defense.

There is possibly a greater field for the development of submarines for the defense under these conditions than there is for the attack.

Blockading ships will doubtless alter their positions from time to time. Advantage of this should be taken by the defense and mines planted at night in waters which later may be occupied by the enemy's fleet.

Further operations by the defense depend upon the movements of the enemy as the blockade from time to time assumes some other form of attack.

Constant readiness to meet a change of conditions is essential.

4. A bombardment will have for its object the destruction of ships, docks, storehouses, magazines or batteries. It may also be desired to affect the morale of the defense as a preliminary to other formations.

Mortar batteries are of particular value in compelling the abandonment of bombardments.

This form of attack will occur from time to time during a blockade, supremacy of the sea not requiring the saving of ammunition.

In addition to using mortars such gun fire as would be effective should be brought to bear upon the enemy by the defense.

5. A direct attack may occur at any time after supremacy of the sea is assured.

Clearing the channel of mines and other obstructions will be a preliminary operation in this form of attack.

Merchant vessels may be used to explode mines and should be destroyed before accomplishing their purpose. Attempts made under cover of darkness to cut cables should be prevented by the vigilance of patrol boats and watchers ashore.

Countermining operations and sweeping the channel necessitate the use of specially adapted vessels. These at once become targets for the defense and should be destroyed in the manner best suited to existing conditions (by means of rapid fire guns, torpedoes, or submarines, depending upon the operations of the fleet).

Mines removed or exploded should be replaced by the defense as soon as possible.

Mines and obstructions having been disposed of, an attack in the nature of a run-by may be attempted with a view to the reduction of the fortifications.

This will probably not be risked unless a bombardment at medium ranges has shown the possible superiority of the fleet over the batteries and floating defenses.

The attacking forces will approach the harbor with battleships, cruisers and torpedo-boats. The latter will be concealed as long as possible and sent forward at full speed under cover of the fire of their fleet so as to divert attention of observers and gunners at a critical time.

Mortar batteries should open fire at leading battleship, or cruiser, other batteries taking up the leading target as it comes within range.

Batteries assigned to the defense of mine fields should fire on torpedo boats.

Fire should be concentrated on leading ships until they are disposed of, or disabled.

6. Combined land and naval operations provide the only forms

of attack by means of which an enemy may hope to accomplish the actual downfall of a strongly fortified harbor.

Preparations for defense will include not only the manning of the permanent fortifications and their accessories but also the disposition of Coast Artillery supports and a coast guard.

It may be seen from the above discussion of possible operations within the vicinity of a fortified harbor during the continuance of hostilities that a complete transformation from the conditions existing prior thereto will be effected. A knowledge of all the conditions affecting any form of attack in a particular locality, however, makes it possible to prepare a scheme of defense capable of execution without confusion or unnecessary delay. The War Department has already taken steps to insure the carrying out of predetermined plans incident to the land defense of fortified harbors. It is equally important that plans be prepared which shall cover every probable military disposition connected with the various forms of naval attack.

These latter plans with those of the Land Defense Board should appear in the Fort Record Books for each district and should cover every question that can be disposed of prior to the opening of hostilities.

The following outline is suggested as a model, the completion of which, or of one along similar lines, should be required of all District Commanders, at the earliest practicable date.

1. Statement of the general principles of Coast Defense Par. 1-3, D. R. C. A.
2. Statement of specific problem under consideration, including a discussion of the strategic and commercial importance of the locality, reasons for its defense, reasons for attack by an enemy and the probable form of attack deduced from the importance of the position.
3. Preparation of a good contoured map showing sea and land areas within ten miles of fortifications.
4. General description of the locality represented on map, nature of approaches, character of ground, striking features affecting military situations, etc.
5. Nature and extent of the completed seacoast defenses including a description of all available coast artillery material.

Under heading armament submit tables showing quantities of ammunition and submarine mine material on hand and quantities needed for proper defense.

Indicate steps to be taken to supply deficiency.

6. The adopted organization of the several units into a tactical chain of artillery command.

7. Floating defenses available and organization thereof.

Tables showing what is desired for a proper defense.

Plans for obtaining commercial boats in vicinity of district with description of those available.

Uses to which floating defenses will be put with particular reference to an efficient service of security and information.

8. Tables showing personnel necessary for each element of the defense.

Tables showing personnel available from regular garrison, coast artillery reserves and coast artillery supports assigned to district.

Remarks on any probable deficiency in personnel.

9. Discussion of the local land defense problem.

Duties of artillery supports and coast guard.

Plans for the preparation of lines of defense, shelter, subsistence and supplies for coast guard and supports with appendices pertaining to specifications for construction work, division of labor among various departments and estimates of time and cost to complete work as planned. (This subhead will include the plans prepared by the Land Defense Board.)

10. Discussion of conditions which will probably exist in a district at the beginning of preparations for active defense.

Administrative duties to be attended to in connection with carrying out predetermined plans, orders to be issued, etc.

11. Detailed orders for manning fortifications and fighting fort personnel, under all forms of attack.

12. Comments and recommendations.



THE ALTITUDE FACTOR AGAIN

By CAPTAIN R. K. HEZLET, Royal Artillery

The correction that it is necessary to apply to the ballistic coefficient for variations in the density of the air has already been very fully discussed in papers in the JOURNAL OF THE UNITED STATES ARTILLERY by Colonel Ingalls, Captain Alston Hamilton and Professor Alger. It is therefore with some diffidence that the present writer ventures to put forward a suggestion for a modification of the treatment of the question, but the object in view has been to, if possible, simplify this treatment. Alston Hamilton's tables* for the surface density factor alone extend to eight pages of the JOURNAL, while those for the altitude factor occupy four more.

We have as an expression for the ballistic coefficient with the usual notation

$$C = f \frac{\delta_0}{\delta} \frac{W}{\beta c d^2}$$

It is proposed to deal here only with the first two factors, viz.

The service density factor $\frac{\delta_0}{\delta}$ and the altitude factor f , δ_0 denoting the standard density of the air, for which the ballistic tables are calculated and δ the density of the air at the level of the gun at the time of firing.

The density of the air depends on the pressure, b inches of mercury as recorded by the barometer, the temperature, t degrees Fahrenheit as recorded by the thermometer, and the degrees of humidity S , saturation being denoted by $S = 1$.

The formula for δ in grains per cubic foot is then

$$\delta = \frac{9280 b}{459 + t} - \frac{3480 S F}{459 + t} \quad (1)$$

F being the pressure of the aqueous vapor at the temperature t , which can be obtained from tables.

* Supplement to Journal U. S. Artillery, Vol. 24, No. 2, Sept.-Oct., 1905.

The standard density δ , for Ingall's ballistic tables is 527 grains per cubic foot, corresponding to

$$b = 29.56 \text{ ins. (750 mm.)}, t = 59^\circ \text{ F (15}^\circ \text{C)}, S = 0.5^*$$

It will be noticed that the first member of the right hand side of equation (1) is independent of the degree of humidity while the second member is independent of the pressure.

Following the British "Text Book of Gunnery" we shall write

$$\tau = \frac{\partial}{\partial t}$$

τ being termed the "coefficient of tenuity."

The appearance of the coefficient τ in the denominator of the expression for the ballistic coefficient will cause no inconvenience if a 20-inch slide rule, which in practice gives quite sufficient accuracy, be used to evaluate C , while the construction of a table of values of τ is easy, as for any value of t , and a constant degree of humidity, the values of τ for different values of b lie on a straight line.

Table A gives the values of $\tau = \frac{\partial}{\partial t}$ for $b = 30''$, $S = 0.5$ for temperatures from 0° to 100° F , and the column of differences for 1 inch alteration in the barometer enables the value of τ for any other value of b to be readily determined, using a slide rule for the proportional parts.

To save any extrapolation a graphic representation can also be effected on the following lines, with $\delta = 527$ grains per cubic foot, and $\tau = \frac{\partial}{\partial t}$ we have from equation (1)

$$\tau = \frac{9280 b}{527(459 + t)} - \frac{3480 \times 0.5 F}{527(459 + t)}$$

As F is a function of t this equation is of the form

$$\tau + b \varphi(t) + \Psi(t) = 0$$

where $\varphi(t)$ and $\Psi(t)$ are functions of t .

Any equation which can be reduced to this form can, as shown by M. d'Ocagne,[†] be represented by a "nomogramme" in which the scales of τ and b lie on parallel straight lines, while the scale of t is on a curved line. Fig. 1 shows this graphic repre-

* The standard for the British ballistic tables is 534.2 grains per cubic foot, corresponding to

$b = 30 \text{ ins.}$ $t = 60^\circ \text{ F.}$ $S = \frac{1}{3}.$

[†] Vide d'Ocagne "Traité de Nomographie" (Paris, 1899).

sensation and gives the values of τ corresponding to any values of b from 26" to 31", and any values of t from 0° to 100°. The three scales are so constructed that any straight line drawn to cut the three scales intersects them at corresponding values of b , t and τ .

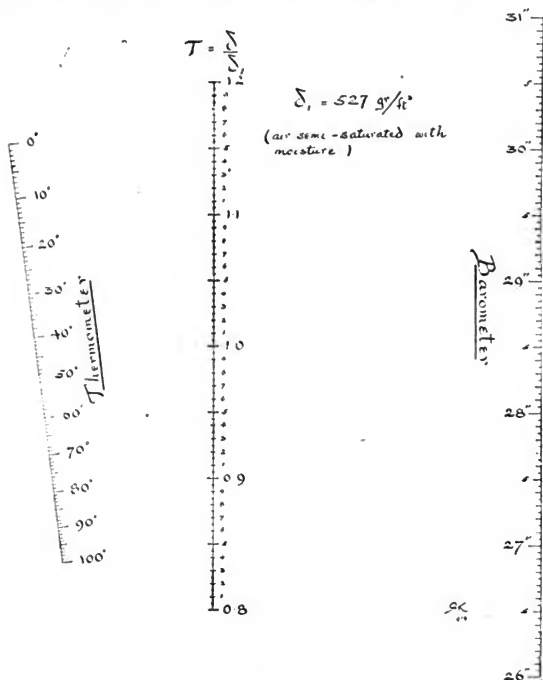


Fig. 1.

Hence to find the value of τ for any value of b and t we join the pressure on the barometer scale to the temperature on the thermometer scale and the intersection of this straight line with the τ scale gives the value of τ for this pressure and temperature.

For example, $b = 28.55''$, $t = 74^\circ$, what is the value of τ ?

Joining 28.55 on the barometer scale to 74° on the thermometer scale, the τ scale is cut at 0.938, the required value of τ .

So far we have only dealt with a constant degree of humidity $S=0.5$. For ordinary work this is quite sufficiently accurate, but the variations in the value of τ for different degrees of humidity become serious in refined experimental work when the temperatures are over 40°F .

Referring to equation (1) it will be seen that variations in the degree of humidity only affect the second member on the right-hand side. We can, therefore, draw up a table giving a simple + or — correction to apply to the value of τ as determined for $S=0.5$ for varying degrees of humidity.

Table B is for this purpose, the arguments being the temperature and the difference between the readings of the wet and dry bulb thermometers, which is the usual practical way of estimating the humidity.

For example, $b=30^{\circ}$, $t=85^{\circ}$, difference between dry and wet bulb readings $=2^{\circ}$, what is the value of τ ?

From Table A the value of τ for $S=0.5$ is 0.964, but referring to Table B we see that for the given conditions a correction of -0.006 is necessary.

The corrected value of τ is therefore 0.958.

When the height of the trajectory becomes at all considerable, it is necessary to apply some correction to the surface density factor as the density of the air decreases with the altitude.

Denoting by h the mean height of the trajectory in feet, and by δ_h, τ_h , the values at the height h , while δ_o, τ_o refer to the values at the level of the gun, we have

$$\frac{\partial_t}{\partial_h} = f \frac{\partial_t}{\partial_o} = \frac{1}{\tau_h}$$

$$\text{or } f = \frac{\tau_o}{\tau_h}$$

To investigate the decrease in the density of the air with the altitude we will discuss separately the alterations in temperature, pressure and humidity.

(1) *Fall of Temperature with Altitude.*—It is a well-known fact that, disregarding the exceptional occurrence of “inversions” at certain heights, the temperature decreases as the altitude increases. A great deal of experimental work has been carried out to determine the rate of this decrease, especially of recent years with the aid of registering balloons and kites. In examining the results one is confronted by such variations both seasonal and diurnal, as well as by the presence (generally in winter) of the

so-called inversions of temperature already referred to, that only a very approximate mean value can at the best be hoped for.

All the most recent observations are collected and discussed in the British Association Report "On the Present State of Our Knowledge of the Upper Atmosphere", (Winnipeg, 1909).

The curve showing the fall in temperature with altitude in Fig. 2 has been deduced from the results given in the above report. The means of the mean gradients for different altitudes as deduced from Berson's manned balloon ascents, 1899, manned balloon ascents, 1901-1907, registering balloon ascents for ten European

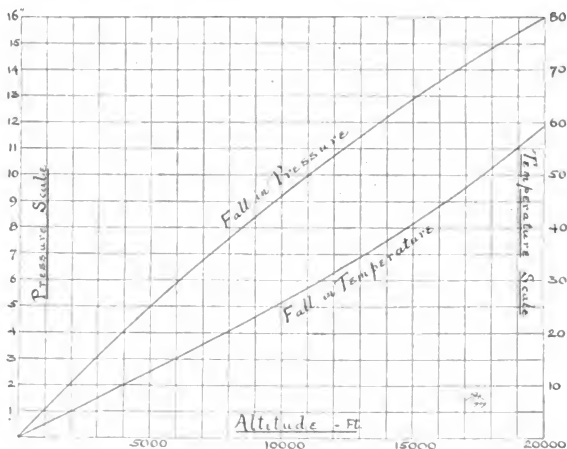


Fig. 2.

stations, and registering balloon ascents St. Louis, U. S. A., were taken as the basis of this curve.

Up to 5,000 feet the mean gradient may be taken as 2.5°F. per 1,000 feet but beyond this altitude a linear law is not reliable.

(2) *Fall in Pressure with Altitude.*—When we come to consider the decrease of pressure with altitude we are on surer ground. The well-known formula, based on Laplace's treatment, connecting barometric pressure and altitude has been frequently tested and found reliable. We have, putting the formula in a form suitable for our purposes—

$$\log b_h = \log b_0 - \frac{h}{60370 \left(1 + \frac{t_h + t_0}{500}\right)} \quad (2)$$

where t_h , t_0 are in degrees centigrade.

Taking t_h from the curve in Fig. 2 we can calculate b_h , for any value of h and so starting with a mean $b_0 = 30''$ obtain the curve in Fig. 2 of decrease of pressure with altitude.

But if the results of formula (2) are compared with those of the simple isothermal formula

$$\log b_h = \log b_0 - \frac{h}{60,000} \quad (3)$$

or Babinet's modification [which only takes into account the first term of the expansion of (3) ,

$$b_h = b_0 \left(\frac{55000 - h}{55000 + h} \right) \quad (4)$$

the differences from the ballistic point of view are quite negligible, so that our rate of decrease of pressure with altitude is practically independent of the temperature and consequently we may rely on the curve in Fig. 2 as giving a very satisfactory approximation.

Up to 5,000 feet we may take 1 inch fall of barometer per 1,000 feet but beyond this the curve should be followed.

The curves shown in Fig. 2 were plotted from the points determined for 5,000, 10,000, 15,000, 20,000 feet, viz:—

h	0	5,000	10,000	15,000	20,000
Fall in t	0°	12.5°	26.5°	41.5°	59.5°
Fall in b	1"	5"	9.2"	12.9"	16"

3. *The Alteration of Humidity with Altitude.*—The effects of the alteration of humidity with altitude on the density of the air are small compared with the effects of the alterations in temperature and pressure. This combined with the fact that experiments give very discordant results will justify us in neglecting this alteration and considering the degree of humidity as constant.

We are now in a position to correct the Ballistic Coefficient or a mean height of trajectory h .

We take the decrease in temperature and pressure for the height h from the curves in Fig. 2 and correct the readings of the

barometer and thermometer at the level of the gun accordingly. We can then determine τ_h employing Table A or the graphic diagram in Fig. 1.

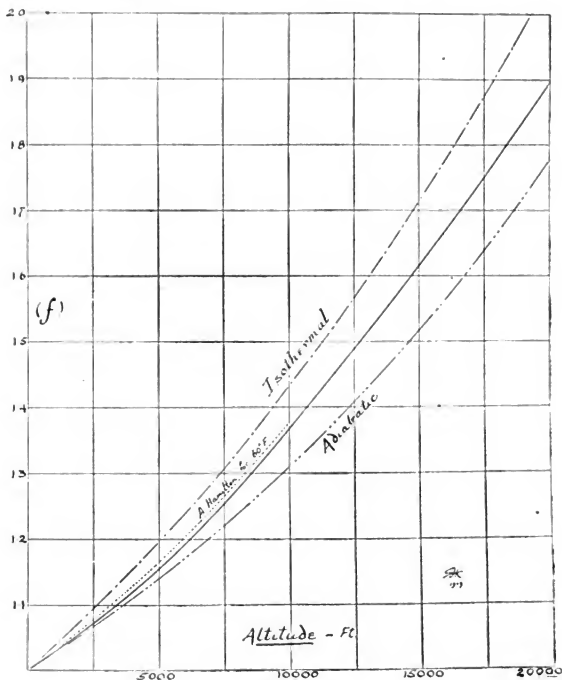


Fig. 3.

With this method our expression for the ballistic coefficient is

$$C = \frac{w}{\tau_h \beta c d^2}$$

For purposes such as the compilation of range tables for normal conditions and also for problems where the ground readings are not recorded we may draw up a table of

$$f = \frac{\tau_o}{\tau_h}$$

using the curves in Fig. 2 and $b_o = 30''$, $t = 60^\circ$.

The resulting curve is plotted in Fig. 3* where, for comparison, we have inserted the isothermal curve, as proposed by Colonel Ingalls, and the adiabatic curve as proposed by Professor Alger; Captain Alston Hamilton's curve for 60°F is also shown and runs, as may be expected, very close to the proposed curve, the difference being due to the fact that he takes a uniform fall of 1°F per 300 feet altitude, which is a value that has hitherto been very generally accepted.

To exemplify the application of the treatment proposed above we will now work out two examples which have already appeared in the JOURNAL U. S. ARTILLERY.†

Example I.—6-inch gun:

$$\begin{aligned} V &= 3003 \\ b_0 &= 29''.786 \\ t_0 &= 46^\circ.81 \\ w &= 106 \text{ lbs.} \end{aligned}$$

$$\text{Quadrant elevation} = 12^\circ.$$

$$\text{Jump} = 0'.$$

$$\text{Height of gun above water} = 19.88 \text{ feet.}$$

$$\text{Observed time of flight} = 24.7 \text{ sec.}$$

$$\text{Measured range} = 10742 \text{ yards.}$$

Find c .

Working with a 20-inch slide rule and Ingall's tables and assuming the rigidity of the trajectory:

$$\text{Curvature} = 24.8 \text{ ft.}$$

$$\text{Corrected height of gun} = 44.68 \text{ ft.}$$

$$\epsilon = 4'.8$$

$$\varphi = 12^\circ 5'$$

$$\frac{\sin 2\varphi}{X} = C' = 0.0000127$$

$$\frac{X}{C} = Z = 12750$$

$$\frac{X}{Z} = C = 2.53$$

$$4T^2 = y_0 = 2440 \text{ ft.}$$

$$\frac{2}{3}y_0 = h = 1630 \text{ ft.}$$

$$b_h = 28''.15$$

* If $\frac{1}{f} = r_h$ be plotted it will be found that up to 10,000 ft., $r_h = 1 - 0.000027h$ very nearly, which is a convenient way to apply the correction for normal surface conditions.

† Vol. 24, p. 109.

$$\begin{aligned}
 t_h &= 43^\circ \\
 \tau_h &= 0.986 \\
 \beta c &= 1.18 \\
 \frac{1}{\beta} &= 0.995 \\
 c &= 1.174
 \end{aligned}$$

Alston Hamilton (loc. cit.) gives $c=1.11742$ but two values of $\log f_a$ appear in his calculation; if the first is used the result is about $c=1.18$, while the amount of labor involved in the two calculations is very different

Example II. $V = 1000$ f.s. $\varphi = 59^\circ$
 $X = 7780$ yds. $d = 12''$
 $t = 65^\circ$ $b = 31''$
 $w = 1000$ lbs. Find c

Working in the usual way with Ingall's Table IV we get

$$\begin{aligned}
 C &= 6.68 \\
 \frac{w}{d^2} &= 6.95 \\
 0.45 X &= y_0 = 10500 \text{ feet} \\
 \frac{2}{3} y_0 &= h = 7000 \text{ feet} \\
 b_h &= 24.2'' \\
 t_h &= 47^\circ \\
 \tau_h &= 0.809 \\
 c &= 1.287
 \end{aligned}$$

TABLE A.

Values of $\tau = \frac{\delta}{\delta_0}$ for $\delta_0 = 527$ grains per cubic feet, barometer 30 ins. and air semi-saturated with moisture.

t°	$\tau = \frac{\delta}{\delta_0}$	Difference for 1 in. Bar.	t°	$\tau = \frac{\delta}{\delta_0}$	Difference for 1 in. Bar.
0	1.151	0.0384	11	1.124	0.0375
1	1.148	0.0383	12	1.121	0.0375
2	1.146	0.0383	13	1.119	0.0374
3	1.143	0.0382	14	1.116	0.0373
4	1.141	0.0381	15	1.114	0.0373
5	1.139	0.0380	16	1.112	0.0372
6	1.136	0.0379	17	1.109	0.0371
7	1.134	0.0379	18	1.107	0.0370
8	1.131	0.0378	19	1.104	0.0369
9	1.129	0.0377	20	1.102	0.0368
10	1.126	0.0376	21	1.100	0.0367

TABLE A—Continued

t°	$\tau = \frac{\delta}{\delta_t}$	Difference for 1 in. Bar.	t°	$\tau = \frac{\delta}{\delta_t}$	Difference for 1 in. Bar.
22	1.097	0.0367	61	1.013	0.0338
23	1.095	0.0366	62	1.011	0.0338
24	1.092	0.0365	63	1.009	0.0337
25	1.090	0.0364	64	1.007	0.0337
26	1.088	0.0363	65	1.004	0.0336
27	1.086	0.0363	66	1.002	0.0335
28	1.083	0.0362	67	1.000	0.0335
29	1.081	0.0361	68	0.998	0.0334
30	1.079	0.0360	69	0.996	0.0333
31	1.077	0.0360	70	0.994	0.0333
32	1.075	0.0359	71	0.992	0.0332
33	1.072	0.0358	72	0.990	0.0332
34	1.070	0.0357	73	0.988	0.0331
35	1.068	0.0357	74	0.986	0.0330
36	1.066	0.0356	75	0.984	0.0330
37	1.063	0.0355	76	0.982	0.0329
38	1.061	0.0355	77	0.980	0.0329
39	1.059	0.0354	78	0.978	0.0328
40	1.057	0.0353	79	0.976	0.0328
41	1.055	0.0352	80	0.974	0.0327
42	1.053	0.0352	81	0.972	0.0327
43	1.050	0.0351	82	0.970	0.0326
44	1.048	0.0350	83	0.968	0.0325
45	1.046	0.0349	84	0.966	0.0325
46	1.044	0.0349	85	0.964	0.0324
47	1.042	0.0348	86	0.962	0.0324
48	1.040	0.0347	87	0.960	0.0323
49	1.038	0.0347	88	0.958	0.0322
50	1.036	0.0346	89	0.956	0.0322
51	1.034	0.0345	90	0.954	0.0321
52	1.032	0.0344	91	0.952	0.0321
53	1.030	0.0344	92	0.950	0.0320
54	1.028	0.0343	93	0.948	0.0319
55	1.025	0.0342	94	0.946	0.0319
56	1.023	0.0342	95	0.944	0.0318
57	1.021	0.0341	96	0.942	0.0317
58	1.019	0.0340	97	0.940	0.0317
59	1.017	0.0340	98	0.938	0.0316
60	1.015	0.0339	99	0.936	0.0316
			100	0.934	0.0315

TABLE B.

Correction for degree of humidity to be applied to the last figure

of $r = \frac{\delta}{h}$ as found from Table A.

Difference between Dry and Wet Bulb Readings.

Dry bulb	0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°
40°	-2	-1	-1	0	0	0	+1				
41	-2	-1	-1	0	0	0	+1				
42	-2	-1	-1	0	0	0	+1				
43	-2	-1	-1	0	0	0	+1				
44	-2	-1	-1	0	0	0	+1				
45	-2	-1	-1	0	0	0	+1				
46	-2	-1	-1	0	0	0	+1				
47	-2	-2	-1	0	0	0	+1				
48	-2	-2	-1	0	0	0	+1				
49	-2	-2	-1	-1	0	0	+1				
50	-2	-2	-1	-1	0	0	+1	+1	+1		
51	-2	-2	-1	-1	0	0	0	+1	+1		
52	-3	-2	-1	-1	0	0	0	+1	+1		
53	-3	-2	-1	-1	0	0	0	+1	+1		
54	-3	-2	-1	-1	0	0	0	+1	+1		
55	-3	-2	-1	-1	0	0	0	+1	+1		
56	-3	-2	-1	-1	0	0	0	+1	+1		
57	-3	-2	-1	-1	0	0	0	+1	+1		
58	-3	-2	-2	-1	0	0	0	+1	+1		
59	-3	-2	-2	-1	0	0	0	+1	+1		
60	-3	-2	-2	-1	0	0	0	+1	+1	+1	
61	-3	-2	-2	-1	-1	0	0	+1	+1	+1	
62	-3	-3	-2	-1	-1	0	0	+1	+1	+2	
63	-4	-3	-2	-1	-1	0	0	+1	+1	+2	
64	-4	-3	-2	-1	-1	0	0	+1	+1	+2	
65	-4	-3	-2	-1	-1	0	0	+1	+1	+2	
66	-4	-3	-2	-1	-1	0	0	+1	+1	+2	
67	-4	-3	-2	-1	-1	0	0	+1	+1	+2	
68	-4	-3	-2	-1	-1	0	0	+1	+1	+2	
69	-4	-3	-2	-2	-1	0	0	+1	+1	+2	
70	-4	-3	-2	-2	-1	0	0	+1	+1	+2	+2
71	-4	-3	-2	-2	-1	0	0	+1	+1	+2	+2
72	-5	-4	-3	-2	-1	0	0	+1	+1	+2	+2
73	-5	-4	-3	-2	-1	0	0	+1	+1	+2	+2
74	-5	-4	-3	-2	-1	0	0	+1	+1	+2	+2
75	-5	-4	-3	-2	-1	0	0	+1	+1	+2	+2
76	-5	-4	-3	-2	-1	-1	0	+1	+1	+2	+2
77	-5	-4	-3	-2	-1	-1	0	+1	+1	+2	+2
78	-6	-5	-3	-2	-1	-1	0	+1	+1	+2	+2
79	-6	-5	-3	-2	-1	-1	0	+1	+1	+2	+2

TABLE B.—Continued

Dry bulb	0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°
80°	—6	—5	—3	—2	—1	—1	0	+1	+1	+2	+2
81	—6	—5	—4	—3	—2	—1	0	+1	+1	+2	+2
82	—6	—5	—4	—3	—2	—1	0	+1	+1	+2	+2
83	—6	—5	—4	—3	—2	—1	0	+1	+1	+2	+2
84	—7	—5	—4	—3	—2	—1	0	+1	+1	+2	+2
85	—7	—6	—4	—3	—2	—1	0	+1	+1	+2	+2
86	—7	—6	—4	—3	—2	—1	0	+1	+1	+2	+2
87	—7	—6	—4	—3	—2	—1	0	+1	+1	+2	+2
88	—7	—6	—5	—3	—2	—1	0	+1	+1	+2	+2
89	—8	—6	—5	—3	—2	—1	0	+1	+1	+2	+2
90	—8	—6	—5	—4	—2	—1	0	0	+1	+2	+2
91	—8	—7	—5	—4	—3	—2	0	0	+1	+2	+2
92	—8	—7	—5	—4	—3	—2	0	0	+1	+2	+3
93	—9	—7	—5	—4	—3	—2	0	0	+1	+2	+3
94	—9	—7	—6	—4	—3	—2	—1	0	+1	+2	+3
95	—9	—7	—6	—4	—3	—3	—1	0	+1	+2	+3
96	—9	—8	—6	—4	—3	—2	—1	0	+1	+2	+3
97	—10	—8	—6	—5	—3	—2	—1	0	+1	+2	+3
98	—10	—8	—6	—5	—4	—2	—1	0	+1	+2	+3
99	—10	—9	—7	—5	—4	—2	—1	0	+1	+2	+3
100	—11	—9	—7	—5	—4	—2	—1	0	+1	+2	+3



DESCRIPTION OF A "SUB-TARGET" DEVICE FOR THE COAST ARTILLERY

By CAPTAIN S. F. BOTTOMS, Coast Artillery Corps

The construction of this device is based upon the following considerations: If the D.P.F. instrument be surrounded with a cylindrical screen of proper diameter, and the image of a target be projected on the inside of the screen, and this image be made to move mechanically at the proper rate in any desired direction, the path described by the image on the screen may, for all practical purposes, be taken as the perspective of the path of a *real target* proceeding across the field of fire in such a direction and at such a rate as to make the perspective of its path on the screen coincide with the path described by the image. Since the image must move in azimuth at a uniform rate the only target whose motion across the field of fire can be faithfully reproduced by the motion of the image on the screen will be one which moves at a uniform rate at *any constant range*. The perspective of the path of such a target on the screen would be a circle whose plane would be horizontal. For targets moving in any other manner than at a *uniform rate* and *constant range* it would be difficult to follow mechanically with an image the projection of their paths on the screen, due to the fact that the image moves uniformly in azimuth whatever be its direction on the screen. While the projection of a real target on the screen while describing any path not at constant range would not move uniformly in azimuth. So if we attempt to plot the image of a target which changes in range as well as azimuth, its track as plotted on the plotting board will be that of a target moving at a constantly increasing or decreasing range and at a speed which would be constantly increasing, or decreasing, which is a condition of course not to be met with, to any extent, when tracking a real target. This, however, would not interfere with the practice to be obtained from using such a moving picture for a moving target as the corrections obtained from the range and deflection boards would either be uniform or else increasing or decreasing at a rate that would vary uniformly, and the results of the work of the several members of the range and position finding details could be examined and checked with as much

accuracy as if the observations had been made on a *real target*. By varying the direction and the rate of the uniform motion of the image, the motion of any *real target* can be more or less faithfully reproduced, subject of course to the limitations mentioned above.

The object of such a device is to furnish a satisfactory substitute for a real target when for any reason a real target is not available during the drill hour. In many respects the sub-target described above will be more valuable for drill than a real target, for the reason that it moves with almost absolute uniformity, and any erratic results obtained can be attributed to error on the part of some member of the position-finding detail and not to erratic motion of the target. To find the mistake and correct it, it is only necessary to send the sub-target over the same course under the same conditions which of course can not be done very easily with a real target.

Such a device has been constructed at this post and a short test of the working of it indicates that it will perform satisfactorily all that is expected of it.

For the construction of this machine it was only necessary to procure a small motor, $\frac{1}{2}$ H. P., gear it down to the proper rate, so as to drive a small platform at the rate desired and mount upon the platform a toy magic lantern for projecting the image of a target upon the screen. A circular spot of light would have answered the purpose just as well, perhaps, but to make the target appear more real a lantern slide was prepared showing the image of a steam ship. As an object at a distance of four feet can not be viewed through the telescope of the D.P.F., an auxiliary telescope was made by mounting a suitable lens in the end of a mailing tube and mounting the improvised telescope on top of and parallel to the telescope of the D.P.F. Transit telescopes are now provided with a short focusing attachment for viewing near objects. It is thought that the D.P.F. telescope could be fitted with a similar attachment, or furnished with a cheap auxiliary telescope. A screen eight feet in diameter was attached to the ceiling of the observing station in such a way as to be let down around the instrument when in use, or hoisted to the ceiling out the way when not in use. All the machinery necessary was mounted in a box 14"x22"x10". When the machine is not in use it may be easily moved to one side out of the way.

It is also suggested that Coast Artillery companies of the national guard might find such a device of service for use in their armories.

PROFESSIONAL NOTES

THE WRIGHT FLYER AND ITS POSSIBLE USES IN WAR

By Lieutenant F. E. HUMPHREYS, Corps of Engineers

Flying consists in sustaining a body in the air against the force of gravity by means of the dynamic action of the air against some movement of the body. Men have attempted to fly in three different types of machine, the ornithopter, which flaps its wings in imitation of the flight of birds; the helicopter, which lifts itself by the use of vertical propellers, and the so-called aeroplane, which is sustained by the reaction of the air on inclined surfaces.

Neither the ornithopter nor the helicopter has given practical results. The aeroplane is the one which has made all the flights worth mentioning and is at all practical.

The word "aeroplane" is decidedly a wrong name to apply to the present day machine, as the surfaces used are not planes but curved surfaces. The Wright brothers and several New York papers have introduced the use of the word "flyer," which is much more appropriate.

The Wright flyer which has been purchased by the Army for instruction and experimentation consists of two main surfaces, a forward elevating plane, a steadying plane in rear and two vertical rudders for steering.

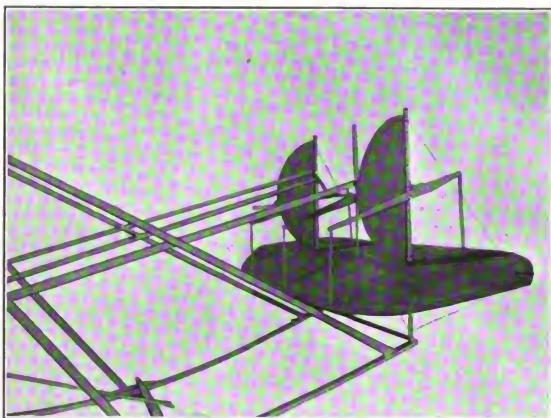
The main surfaces do the actual supporting of the flyer. They are about 36 feet long, 5.2 feet deep, superposed with 5.2 feet between the surfaces. These, like the main surfaces in other successful machines, are concaved downward, as can be seen in the illustrations.

The forward plane is used for elevating and depressing the flyer. It is about 15 feet long and 3 feet wide, arranged so that it is concaved on whichever surface is bearing. This is seen in Figs. 1 and 2, in one of which it is in position for elevating and the other for depressing.

The steadying plane is of the same form as the front elevating plane, but is rigidly attached and has no motion. This plane was at first used superimposed on the front plane and having the same motion, but was changed to the rear to give greater steadiness. Fig. 3 shows the old arrangement, and Fig. 4 the new.

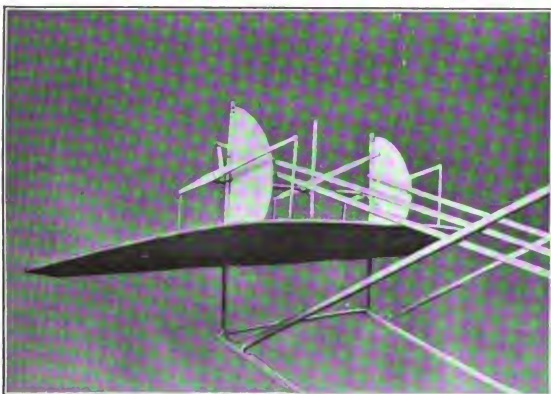
The vertical rudders are two planes, each about $1\frac{1}{2}$ by 6 feet, placed $1\frac{1}{2}$ feet apart and 8 feet behind the main surfaces. They guide the flyer in the air in the same manner that a rudder guides a ship in the water.

To secure lateral stability the tips of the main surfaces can be warped. This idea was first used by the Wrights and is one of their patents, but it is now used by several foreign aviators, notably Bleriot and the Antoinette Company. The lawsuit of the Wrights against the Sydney Bowman Automobile Company when they imported a Bleriot machine to sell in this country was over this point.



Professional Memoirs

FIG. 1. FORWARD PLANE IN POSITION FOR ELEVATING.



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FIG. 2. FORWARD PLANE IN POSITION FOR DEPRESSING.

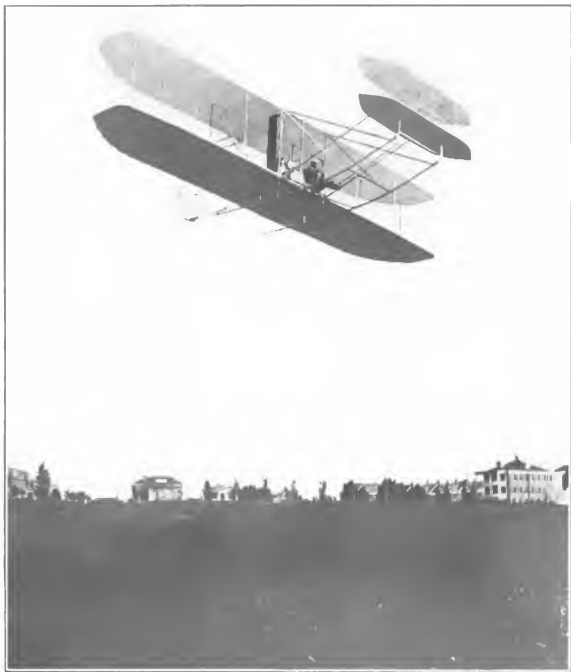


FIG. 3. MR. ORVILLE WRIGHT FLYING. FIGURE SHOWS THE OLD ARRANGEMENT OF FORWARD PLANES.



Professional Memoirs

FIG. 4. STEADYING PLANE, SHOWING NEW RIGID ARRANGEMENT
AT THE REAR OF THE FLYER.

The main surfaces are in three parts, a main central section and two wing tips. The central section is 13 feet long and each tip 11½ feet long. There are between these sections joints movable in a vertical section. The entire front of the main surfaces is trussed by wooden struts and steel wires and is immovable. The middle section is similarly trussed in rear and also cross-trussed from front to rear. The end sections, however, are trussed in rear, as shown in the diagram (Fig. 5).

From this it is seen that if the lower wire is pulled toward the left the right tip will be pulled down and the left up, and vice versa. Then, as the front of the surfaces is immovable, a movement of the wire in any direction will warp the tips and cause them to present a greater angle on one side and a lesser on the other side, thus giving an increased lift of the side of the greater angle and a diminished lift on the other side. (See Figs. 6 and 7.)

(For small angles the greater the angle the greater the lift. The exact law of this lift, like all other aero-dynamic data, is in dispute, as all the data comes from men who have not built successful machines, and the men who have built successful machines either say nothing or imply that the existing law tables are not correct.)

The flyer is given motion by two propellers about 9 feet in diameter and 11-foot pitch, which revolve in opposite directions at about 350 revolutions per minute. They are driven by chains from the engine.

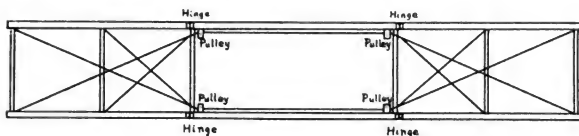


Fig. 5.

The engine is gasoline, four cylinder, water cooled, running at about 1,200 revolutions per minute and giving about 36 horse-power at that speed. It weighs 165 pounds, exclusive of radiator and magneto.

The flyer altogether when leaving the rail with water, gasoline and two men weighs about 1,100 pounds; it goes at a rate of about 40 miles per hour and carries enough fuel for a flight of three and a half hours.

There are several questions which are almost invariably asked by people looking over the machine. One of them is: "What happens when your motor stops? Do you have to come down?"

A flyer is only sustained in the air by the reaction due to its speed, and whenever this is lost the flyer will drop. However, this is never totally lost, as the same force that causes the descent can be used as a motive power to keep up the speed. In other words, if the motor stops, the machine is pointed down at an angle until the component of gravity in the direction it is going is equal to the push required. This keeps up the speed necessary for control, but, of course, makes the flyer gradually descend.

The present flyer can glide down without motor at an angle of from 1 in 5 to 1 in 7.

The next question is: "What use are these things going to be?"

From a military standpoint, the first and probably the greatest use will

be found in reconnaissance. A flyer carrying two men can rise in the air out of range of the enemy, and, passing over his head out of effective range, can make a complete reconnaissance and return, bringing more valuable information than could possibly be secured by a reconnaissance in force. This method would endanger the lives of but two men; the other would detach several thousand men for a length of time and endanger the lives of all.

The next use will probably be in carrying messages. A flyer will average a speed of 40 miles an hour in a straight line. Excepting the telephone and the telegraph, there is no other method of communication as rapid as flying. Automobiles, motor cycles, etc., usually do not average this speed, and very often have to go around two or three sides of a square to get where they are going. This would be particularly valuable for carrying messages between bodies which have been more or less separated, as between the main attack and a flank attack, and between the main body and independent cavalry, or cavalry on a raid.

Another time where advantage might be taken of the speed of these machines is when officers of high rank might desire to give personal supervision at a distant point of the line or to go from one point to another for a council of war. This is particularly the case in modern armies of large size where the front is 70 or 80 miles long. Take an army on a 70-mile front, the army consisting of three parts, the center and the flanks. The commanding officer desires a council of war. The two flank commanders are then about 20 to 25 miles from main headquarters. These men could be brought to the council in three-fourths of an hour by a flyer and returned in about the same time. If they tried to come in an automobile, or on horseback, they might find no good roads, and what there were would probably not be straight and would be certain to be congested. Their progress then would almost certainly be slow, and they would probably be kept from their commands for hours.

As the United States was the only first-class power which signed the Hague agreement as to dropping projectiles from balloons, it is not probable that this agreement will be in force in future wars. Probably a large amount of damage could be done to the personnel of the enemy when in mass, or in a raid to the storehouses and depot, by projectiles dropped from a flyer. That any could be done to fortifications or ships is doubtful.

Flyers might also be used to give warning to war vessels and fleets of an impending attack by submarines. A person looking at water can see down into it only when the angle of the line of sight with the vertical is less than about 50 degrees. In other words, a man at a masthead 100 feet high could not see a submarine until it was about 125 feet away; a man in a flyer 3,000 feet directly over a ship could see a submarine approaching within a radius of 4,000 feet of the vessel and by circling around could greatly extend the zone of protection.

Another remark frequently made is: "Well, I don't see what use these things are if you can't fly except in a large open plain and in a calm or almost a calm."

This is quite reasonable, judging from the flights at Fort Myer and College Park. However, conditions at both places were quite different from those of actual warfare.

At Fort Myer, Orville Wright had a new machine 4 feet less in width and 9 inches less in breadth than usual. He, naturally, did not want to try this machine in anything except a calm, and he waited until the weather conditions were favorable for trying it. When used to the machine, he went up in winds



FIG. 6. WING TIP WARPED TO INCREASE ITS LIFTING EFFORT. THE FAR TIP IS SIMULTANEOUSLY WARPED IN THE OPPOSITE DIRECTION.



FIG. 7. WING TIP WARPED TO DIMINISH ITS LIFTING EFFORT. THE FAR TIP IS SIMULTANEOUSLY WARPED IN THE OPPOSITE DIRECTION.



FIG. 8. SHOWING THE ARRANGEMENT OF MOTOR AND PROPELLERS.

up to 15 miles per hour, but never more than this. His object was to go through the tests and sell his machine to the Government, and he did not care to run any risk of smashing the machine beforehand.

At College Park the object of Wilbur Wright was to instruct two officers in handling the machine. These men had to receive their instruction in a calm and gradually advance to higher wind. To have taken the machine out in high winds would not have been any instruction to the officers and would have risked smashing the machine and having it put out of commission during weather favorable for instruction.

In the hands of experts these machines ought to be able to work in winds up to 35 miles per hour and would be able to work in fields much smaller than College Park.

Of course, accidents of one kind or another are bound to occur, and in open country the damage resulting from any cause, such as the engine stopping or a wire breaking, is greatly decreased. In flying over rough country, any accident is liable to cause serious consequences, especially if the flyer is low down, as it may not be able to avoid trees, houses, trolley wires, telegraph poles, etc. At a great height this risk lessens, as there is then a much larger radius from which to select a landing place.

Of course, in time of war flyers would cross any kind of country, but in their present state of development there is no more reason for risking the lives of aviators by sending them over rough ground unnecessarily than for risking those of soldiers by firing real projectiles at maneuvers.

In addition, it must be remembered that if because of a storm the flyers can not be used the Army is no worse off than if it had none, and the cost and number of men used is insignificant. One officer, ten men and two wagons are a full equipment for a flyer.

Figures 3 and 8 are from photographs borrowed from the office of the Chief Signal Officer, U. S. Army. The remaining photographs are by Sergeant-Major Lefever, Engineer School Detachment.

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THE MILITARY ASPECT OF DIRIGIBLE BALLOONS AND AEROPLANES

(A Lecture delivered at the Royal Artillery Institution, Thursday, November 18th, 1909.)

By Colonel J. E. CAPPER, C. B., R. E., Comdt. and Supt. Balloon School, Aldershot

THE CHAIRMAN: Ladies and gentlemen, Colonel Capper has come here this afternoon to speak to us on the military aspect of dirigible balloons and aeroplanes. It is a subject of vast and ever increasing interest and he is an expert on it as you know. While the question of the conquest of the air is one to which few in the past, but these for a considerable number of years past, have devoted any attention, the speed with which matters aerial have been put to the front lately has drawn the attention of everyone, as instanced by the large audience here to-day, the largest I have ever seen. It must force itself upon us as being a matter which promises to be, if it is not already, a concern of immediate and practical importance. I have pleasure in calling upon Colonel Capper. (Loud applause.)

THE LECTURER: In discussing the bearing on warfare of any new and untried instrument of war, we must recognize that we have no sure grounds of

actual experience on which to base our opinions, but at the same time we are more likely to work on correct lines if we carefully study the results of experiments made in peace time, enquire into developments which are likely to occur in the near future, and trace from these data their probable results on military operations.

At a time when the real conquest of the air is only at its earliest infancy, it would be premature to even hazard a guess as to what the ultimate results of its complete conquest would be on the intercourse and policy of nations, though we may safely assume that the changes will be of the very greatest consequence.

The progress already made, however, although doubtless small, is great enough to force on all nations, who may sooner or later have to embark on military operations, the serious consideration as to how the new instruments of war that are dealt with in this lecture, may assist them, and how far the neglect to use them and to study their use may prejudice them in a struggle with an enemy who is well provided in this respect.

I would propose, therefore, to place before you a short account of progress already made, to inquire into what the probable developments may be in the next few years, and then express my opinion as to how we can best utilize these vessels in war time, and how far neglect of them may prove detrimental to us in any possible conflict in the near future.

I find that even amongst otherwise well informed people, the study of aerial matters is so novel, that there is considerable confusion of ideas as to what the meanings of different terms are.

You must pardon me, therefore, if I start with defining dirigible balloons and aeroplanes.

DEFINITIONS

Dirigible balloons:—

The dirigible balloon or "aerostat" is a composite body which, although it may be in itself very heavy, is on the whole lighter than the air it displaces at ground level, owing to its being lifted by gas which is lighter than air.

It consists of a gas bag, or bags, filled generally with the lightest known gas—hydrogen, to which are attached either by rigid or flexible systems, the motors and propellers (which give it the power of movement through the air), and the personnel who control it.

It is fitted with various contrivances for steering it horizontally, and for lifting or depressing it vertically, and carries supplies of fuel for its motors, and spare weights in the shape of either water or sand, which can be thrown overboard should it become temporarily heavier than the air in which it floats.

Should the propelling system stop it can remain in the air as long as it can remain lighter than the air, but can only float in such direction as the wind currents may take it.

Aeroplanes:—

The "aeroplane," in which general term is, for convenience, included every aerial machine which is heavier than air, has no gas bag, and is only sustained in the air by the operation of its propellers. Should these cease to operate it must come to the ground, though it can be landed safely even under these conditions.

DIRIGIBLE BALLOONS

It is only within the last few years, that the dirigible balloon has met

with any measure of practical success. The cost of initial experiments with it is heavy and has debarr'd all but few working on it.

Small machines, which, comparatively with large ones, offer great resistance to the air, cannot take up motors sufficiently powerful to move them at any rapid speed, and the larger balloons are showing themselves superior in most respects to the smaller ones first constructed.

Journeys of considerable lengths have been made by "dirigibles" of very different types, and the speed already attained has been sufficient to enable them to make successful voyages, even in somewhat unfavorable weather.

Whilst small balloons, like the American "Baldwin," the German "Clouth," and the British "No. 1," are only able to attain a speed of from sixteen to twenty-two miles per hour, and to continue at that speed at from one to four hours with only two as a crew; larger types, as the French "Republique," the German "Parseval," and "Grosse," and the Italian military dirigible, have made journeys of twelve and fourteen hours duration at an average speed of about thirty miles per hour with six or seven passengers, whilst the huge Zeppelin has remained in the air for as much as eighteen hours, has made numerous long journeys to different parts of Germany with a crew of twelve persons, and is said to be capable of a speed approaching thirty-fives miles per hour.

These speeds, through considerable, are far from being sufficient for all purposes, as the speed of the wind at high altitudes surpasses thirty miles an hour on very many days in the year.

It will be seen, therefore, that the dirigibles of the present day are capable of journeys of from 300 to 700 miles under favorable conditions, and are capable of carrying a full working crew besides officers for reconnoitring.

They have also been fitted with wireless telegraph apparatus and have remained in communication with land stations for considerable distances.

They are capable of ascending to heights varying between 4000 and 6000 feet above sea level, and of re-descending and journeying at lower levels, and their gas bags are made of a material which enables them to remain filled, with little leakage, for weeks at a time.

It may be taken as an axiom, therefore, that an up-to-date dirigible balloon is capable of starting in ordinary light weather from Yarmouth, and in the course of twelve hours proceeding as far as either Portsmouth, Southampton, Birmingham or York, and returning again to Yarmouth, when, having taken in fresh supplies of petrol and oil, and some thousands of cubic feet of hydrogen, and possibly a fresh crew, it can again proceed on an equally lengthy journey, throughout the whole of which it may remain at an altitude of a mile above sea level.

A Zeppelin, under similar conditions, starting from Yarmouth could go to and return from any point in England, or the East coast of Ireland, or to Scotland as far north as Glasgow or Dundee.

As long as it remains in the air, a dirigible balloon is fairly safe unless some unfortunate accident should happen to it, such as happened to the "Republique," where a propeller flew off into the balloon and caused a sudden collapse of the whole structure and the violent death of the crew.

It is a moot point whether a balloon has much to fear from electric storms. Many free balloons have been in the air without accident in severe thunderstorms, whilst I only know of one case of one being struck and set on fire, but the chances are so uncertain that in peace time it is always advisable to quit the air should thunder storms approach.

It is when on the ground exposed to the force of the wind, especially when this varies its direction rapidly, that a dirigible balloon is most in danger of destruction, but methods of anchoring these are improving, and it is probable that any well-designed type may be trusted to ride in safety at anchor, in winds up to thirty miles an hour, or even in stronger winds if the engines can be used to assist.

A non-rigid balloon, in case of violent winds, may be rapidly deflated, without damage, except for the loss of the hydrogen it contains, and may either be carted away to be filled again in some sheltered spot, or may be filled again *in situ* when the weather mends.

The Zeppelin, which had the whole of its front torn off by contact with a tree, had a new temporary stem fitted to it in the open, and went to its home under its own power.

AEROPLANES

A year ago most people looked on aeroplanes as little better than toys. Thanks, however, chiefly to the enterprise of the French and the Americans, the development has been very rapid, and aeroplanes of very different patterns have even by this time shown themselves capable of carrying their pilots at great speed for considerable periods, and of rising to considerable heights.

Thus the Wright, Farman, and Voisin biplanes, and the Antoinette monoplane, have remained from two to over three hours in the air, traveling at a speed of from thirty-five to forty-five miles per hour, whilst the Wright machine has risen, in Orville Wright's hands, to a height of 1500 feet, and in Count de Lambert's to nearly an equal height.

It is true that in most cases these long flights have been over open ground, and often at very low levels, but the flights of Farman, Bleriot, Latham, Delagrangé, Wright, Santos Dumont and Cody, over wood, sea, buildings, and railways, and latterly the magnificent flight of de Lambert from Juvisy half across Paris, over the Eiffel Tower and back, show what the machines are capable of when their pilots choose to trust them.

Up to date also, aviators have usually chosen the calmest periods in which to fly, but in the last few months Paulhan has flown in a wind of twenty to twenty-five miles an hour at Juvisy, whilst Latham at Blackpool twice circled the three mile course in a gusty wind which at times was blowing almost as fast as the pace of his machine, which realizes a speed of about forty miles an hour.

As regards weight carrying, many machines have carried a passenger besides the pilot, several have carried two, and Cody has carried a heavy man and twenty-five gallons of petrol—enough to keep his engine running for over four hours.

Enough has, therefore, been done to date to establish the power of an aeroplane to rise in any fairly level open space with a run of from 60 to 200 yards, and in the hands of a skilled operator to travel in fair weather a distance of over 100 miles.

That no long sensational flights, such as that from London to Manchester, have yet been accomplished, must be put down, partly to the large sums of money at the mercy of the limited number of skilled aviators for exhibition flights over small circular courses, and partly to the disinclination of aviators to risk themselves and their machines at present in a flight which must at present impose a severe strain on both them and their engines.

DEVELOPMENTS

Dirigibles:—

As regards developments, it appears probable that the largest dirigible balloons at present constructed do not represent in size the ships of the near future.

Even the Zeppelins, which equal the largest cruisers in size cannot compare with some of those even now contemplated on the Continent, whilst with increase of size will come increase of speed and of carrying capacity, allowing of a larger radius of action, and of carrying very considerable spare weight.

That long journeys will be undertaken is certain, when scientists of such acknowledged renown as Dr. Hergesell are seriously contemplating sending an expedition to Spitzbergen, and thence to the North Pole.

These large ships will, in all probability, be of the rigid type, owing to the comparative safety of that type should accident occur to one of the numerous contained balloons, whilst with the non-rigid and semi-rigid types, should any considerable tear in the envelope occur whilst travelling at high speed, as in the case of the "Republique," the destruction of the vessel is practically assured.

I am of opinion, therefore, that vessels of the semi-rigid and non-rigid type will not tend to increase in size beyond the 250,000 to 300,000 cubic feet vessels already under construction, whilst it is not improbable that the tendency will be to build more easily handled vessels of from 150,000 to 200,000 cubic feet in capacity, but on the other hand the present rigid vessels of 400,000 to 500,000 cubic feet may be replaced by larger ones of 1,000,000 cubic feet or more.

Aeroplanes:—

The astonishing progress made with aeroplanes of various types during the last eighteen months, and the attention which is now being paid to them at home and abroad by very numerous serious engineers and scientists, and the daily developments of light internal combustion engines, cannot but result, in the course of the next few years, in the evolution of machines which will be as far superior to existing ones as the motor car of to-day is in advance of that of 1899.

It is not probable that within so short a space of time as five or ten years, they will enter into the daily life of the people as motors do now, but an aeroplane travelling at great speed and at great heights above our heads will be so common a sight, as not to attract unusual attention, whilst sporting competitions in which they are engaged will not be stopped on account of weather more often than other out-of-door sporting fixtures.

Flight will probably be possible with smaller horse-power than at present; motors will be more reliable and economical of fuel; methods will be adopted for increasing or diminishing speed; automatic or almost automatic stability will be assured, whilst large numbers of men will be able to manage the machines.

With automatic stability the strain on the pilot's nerves will be reduced, and the distance a machine can travel will depend solely on the amount of petrol carried, and the force of the wind with or against it.

There seems no reason why heights of 5000 or 6000 feet should not be attained as easily as 1500 feet, so considerable mountain ranges can be traversed, and it needs little imagination to assume that non-stop runs of 400 or 500 miles will probably not prove uncommon.

By diminishing the amount of petrol carried, one or more passengers can be taken instead, as has already been done for short distances, thus relieving

the pilot of the necessity for observing either his course, or events passing beneath him on the earth.

Experience has already proved that in a good machine in ordinary weather the motion is ideally smooth, so that no obstacles are offered to observation, and photographs can easily be taken, a cinematograph operator having already enabled an audience to see what the ground looked like as it passed below a Wright's machine.

There seems no insuperable difficulty in applying wireless telegraphy to these machines, provided the weight can be kept sufficiently low, so that it is probable that machines so fitted can be in constant communication with the ground.

So far the statements I have made are based entirely either on fact, or are conclusions drawn, I think in no exaggerated way, from fairly certain premises.

MILITARY ASPECT

I pass, however, to the, for us, all important question as to what are to be the uses in war of these machines, and on such an unknown subject I can only offer the opinions I have arrived at after several years of careful study, and I ask you to consider them, not as the ideals of an enthusiast, but as the logical conclusions of a serious student. Many others have studied, and are now studying the subject, and I hope that other students here, who have arrived at similar conclusions, will join in the discussion later, in order that we may be able to get nearer a true conception of the bearings of aerial machines on problems both of tactics and strategy.

Britishers as a rule have all the faults, as well as all the virtues, of intense conservatism. We have little as a race of that valuable quality, imagination, and in considering the importance of any new invention, we are apt to minimise, rather than exaggerate, the purposes to which it may be adapted. I ask you, therefore, especially to avoid belittling the probable effects on war of aerial machines.

Now the first conclusion I have arrived at is, that we must take the subject very seriously; it does not suffice to blind our eyes to patent facts and to say that what has never been done, never will be done, nor must we tackle it in a half-hearted manner.

USES OF DIRIGIBLE BALLOONS

The first and most obvious use to be made of aerial machines is "reconnaissance."

We have in them portable observatories, capable of accompanying armies in the field, and of taking staff officers, photographers, and telegraph operators over the whole theatre of war with the speed of a railway train.

Reconnaissance is of two general types.—"Strategical," which necessitates travelling over very long distances in order to observe the movements of troops, trains, etc., whilst still far distant from our own forces, and "tactical," which entails obtaining detailed information as to the positions and movements of troops within a comparatively small radius.

The necessity of obtaining information is so great, that heavy risks are willingly run in order to secure it, whilst often strategical information is exceedingly difficult, if not impossible, to procure, and serious fighting, leading to heavy loss, especially among our mounted troops, has often to be incurred in order to obtain "tactical" information.

It is obvious that the large dirigible balloon, of the present day even, is

able, *if not interfered with*, to obtain and transmit with speed and accuracy information at great distances from its base on very many days of the year, whilst the smaller balloons are capable, under similar conditions, of doing the same service for short distances, and are especially fitted for tactical reconnaissance.

There is so little doubt as to the immense benefit which even one dirigible balloon could confer on an army, that, if we could be sure it would not be interfered with, it would be madness not to have such vessels with every force.

OBSTACLES

The question then comes in—"what will prevent the dirigible balloon obtaining its information?"

First and foremost is weather, on which it, more than other instruments of war, is especially dependent.

Snow and heavy rain, lightning, and tempest, may hamper the movement of troops and their trains, but they may render a dirigible balloon absolutely incapable of any useful action.

On the other hand, whilst all troops moving on land suffer for a long time from the effects of snow, which lies deep on the surface, and rain, which transforms roads into quagmires, and renders ordinarily harmless streams impassable, the moment fair weather comes, the dirigible balloon, which has remained safe in the shelter of its house during the bad weather, or which has been packed up on its wagons and can be put together and filled in a few hours, can come out, and careless of all obstacles such as swollen rivers, broken bridges, and sodden tracks, proceed about its duties, covering in half an hour what is a laborious day's march for the army, and in a single day reconnoitring an enormous area.

ARTILLERY FIRE

Next comes the question of the enemy's fire.

At heights as great as 5000 or 6000 feet the effect of infantry fire is very small on a balloon. The effect of shrapnel bullets is also small; that of a clean hit or of the base of a shell is greater, but not immediately dangerous, except in the rare case of the motor, or other important piece of the machinery being hit. A lucky burst, however, right on, or in the balloon, would prove at once disastrous.

At such great heights practically only howitzers or specially constructed guns, with high angles of elevation, could reach the balloon.

Krupp has devised a special balloon gun of ingenious construction firing a special shell, the lower part of which is filled with a smoke producing material which enables the trajectory to be seen, whilst the nose is filled with picric acid, and furnished with a percussion fuze so sensitive as to be operated even on striking the fabric of a balloon. A hit by such a shell, which can reach to heights far greater than that at which a dirigible can operate would at once prove fatal to it.

CHANCES OF BEING INJURED

Here it is well to enquire, knowing this special danger to which a balloon is exposed, what are the chances against it?

Naval airships:—

For naval reconnaissance at sea, the balloon is never required to come within range of the enemy's ships. There is no obstacle to its view over the

level sea, the objects it has to observe are large, and can be reported from a great distance, and it need run no risk of destruction from an enemy's guns.

Strategical airships:—

On land, it appears to me that the dirigible used for strategical reconnaissance runs but little danger.

It is impossible to keep batteries of artillery, or even single guns, scattered all over the country with gun crews ready and prepared for instant action, for perhaps weeks together, waiting for the possible advent of an airship, which will only present a target for a very short period of time.

Moreover, in all but very clear skies, an airship can take advantage of low-lying clouds to hide itself from view, descending below them for short periods to observe; under such conditions it is very probable that it may not be seen at all, whilst it can obtain useful information at night by descending to 1500 or 2000 feet or lower, when experience shows, that even when expected, and when looked for by the aid of searchlights, it is a very difficult object to discover, even on a clear night.

Even the special automobile guns, unless present in great numbers, will probably have very few opportunities of firing, roads will not always run in the proper direction to enable them to get within range of an airship when it is seen, whilst we know little as to the probable accuracy of fire of such guns at targets moving at a great pace high in the air.

Tactical airships:—

With tactical airships the circumstances are somewhat different.

Tactical reconnaissance requires to be more detailed than strategical. The numbers of troops, and their exact localities, have to be more precisely recorded, details of earthworks must be studied, and closer observation entails remaining over particular areas for more extended periods.

Moreover, with a field position, large numbers of field guns and howitzers will be distributed over a comparatively small area, and many of these will be available for instant action, whilst numbers of men will be on the look out. The risk to an airship, remaining for any length of time over the enemy's position will probably be very great.

A small and slow airship, with a very limited radius of action, will probably be unable to trust itself, except for very short periods for very special objects within range of the enemy's guns, but even so, such ships may be of very considerable utility as a great deal of detail can be seen from a height of 5000 feet even to a distance of five or six miles, and in savage warfare, where artillery need not be feared, there is no need to keep an airship at a distance.

Such ships, however, I do not advocate, as their speed is small, and in anything but light winds they would be incapable of making the desired point.

An airship with a radius of action, which would enable it to reconnoitre from a safe distance all along the front of an enemy's position, work round it and then along the rear, at all times keeping in touch by wireless telegraphy, would be able to obtain information of the greatest value, and might, especially with a favorable wind, more rapidly from rear to front or vice versa over the position. A good deal can be seen at a height of a mile even when moving at the rate of forty miles per hour, and successful detailed photographs could be made with proper apparatus during such a rush.

The combined work of several airships working in this way should result in a fairly detailed knowledge of all important points of a position and of the distribution of the troops.

There is an aspect of the question which has also to be very seriously con-

sidered, and this is: How are the artillery to know whether an airship within range belongs to their own force or to the enemy? Unless all nations agree to use ships of entirely different design, or of different colors, which seems to be in the highest degree unlikely, it must be exceedingly difficult for a non-expert to distinguish between them.

You can imagine the hesitation of a battery commander in opening fire on a ship, when, if he makes a good shot, he will be uncertain whether or not he is bringing disaster on his own army. He cannot say it is a friend because it comes from a certain direction, the air-ship can come from any direction, and unless he has certain information from some higher authority, it is more than likely he will refrain from firing.

It may, I think, therefore, be accepted that a vast amount of reconnaissance work can be done by such airships with but little risk of danger from the enemy's ships.

Enemy's airships:—

The third obstacle to the use of the airship is the enemy's airship.

Generally speaking in war, like must be fought with like, and I do not think that airships will prove any exception to the rule.

Seeing the vast importance that reconnaissance by these vessels may be to an army, it is absolutely necessary to prevent the enemy enjoying these advantages whilst retaining them for ourselves.

If my conclusions are correct terrestrial artillery will be entirely unable to prevent them obtaining most important information. Therefore we must use aerial.

I consider it essential that any serious war-airship should be capable of attacking a similar vessel of the enemy. In any close encounter the destruction of both attacker and attacked may easily be brought about, and though on neither side would the personnel probably shrink from such mutual destruction, it is desirable to avoid it ourselves, whilst ensuring it to the enemy. There is no particular danger in using naked lights (at a distance from the envelope) on any well made dirigible balloon, the cars of which, whilst remaining light, can easily be made capable of standing the shock of recoil of small guns. A war-airship must, to my mind, carry an armament, probably of very special design, with shells similar to the Krupps, so that one hit on the huge envelope of an enemy will prove destruction to it.

To ensure success we must have numbers of such ships sufficient both to destroy the enemy's air fleet, and leave us with a handsome surplus for other purposes, and the victory will go to those who can move the speediest, maneuver best, and probably highest, and shoot the farthest and straightest.

It is on these, and these alone, that we can depend for ensuring that the enemy shall not be able to observe our movements as we observe theirs.

OFFENSIVE POWER OF AIRSHIPS

There is a second use of airships, which though often exaggerated, we can by no means afford to neglect, and that is their actual offensive use.

Now every large airship has a considerable carrying capacity surplus to the fuel and crew, etc., required even for fairly long voyages, and its armament.

This surplus capacity can be utilized for carrying high explosives.

It is contended by many that it is useless for an airship to carry bombs, as you cannot drop a bomb with any accuracy from any considerable height. But why should such bombs not be fired by compressed air or small charges, so as to start with a fair muzzle velocity? Neither their walls nor the tubes

from which they are fired need be heavy, and with practice fair shooting should be made at the small ranges at which they would be used.

At night when airships can keep low down, I am of opinion they could be used with deadly effect on transports, and with considerable power of destruction on bridges, dock gates, arsenals, etc., whilst incendiary bombs may play havoc in supply depots and stores, and airships so used would cause both moral and material distress to camps, bivouacs and horses, and undoubtedly would harass, by the need for constant watchfulness, posts on the lines of communication and at places far away from the field army.

That the risks to be run by airships so employed would be considerable is undoubted, but I am not disposed to admit that they would be so great that their employment would not be warranted nor do I think we can afford to neglect the possibility of their use in this manner, nor to guard against it in the only possible way by having a sufficiency of airships ourselves to destroy the whole of the enemy's fleet.

TRANSPORT

Suggestions to utilize airships for transporting troops in any numbers may be looked on as chimerical. At the same time they may have a limited but important utility for the purpose of transporting individuals from point to point where roads are blocked, or ordinary facilities wanting, and it is not inconceivable that an airship at the immediate personal disposal of the commander-in-chief might enable him to keep a close and personal view of the distribution of his forces, and the changing incidents of battle, which, with the help of the excellent communication systems now in use, will enable him to recover that direct control over the units of his force, which it is now assumed it will be impossible for him to maintain.

POSITION OF DIRIGIBLE WHEN AT REST

I have hardly time to touch upon such questions as to whether a dirigible balloon should be filled at the base and return there almost daily, or be filled in the field, marching with the army and kept there. Whether it should be kept in the open air either at anchor or fastened to the ground, or whether portable shelters should be carried for it. These are moot points, and besides entailing very considerable questions of transport and personnel, are so dependent on actual experiment, that I am not at present able to offer any opinion of value on the subject.

The only point on which I have a decided opinion is, that all troops not actually engaged in battle, or hastening to points where their immediate presence is necessary, must be instructed to render any required assistance when called on to do so by the officer in charge of an airship. Circumstances may render it necessary for an airship to come to earth in unforeseen places. Its crew, though ample for its management when in the air, are quite insufficient to manage it on the ground, where it is peculiarly helpless, and failure to render active and immediate assistance may easily result in the total destruction of the ship.

USE OF AEROPLANES

I now pass to the consideration of aeroplanes. The aeroplane as at present evolved is of but little use for war. It can be used for carrying in our own country despatches, maps, etc., with speed and certainty in fair weather; it may even carry single passengers from point to point, but it is not yet useful either for reconnaissance or for offence.

Before many years are passed, however, the story will be a different one, and all the uses to which a dirigible balloon can be at present put, can be fulfilled by an aeroplane, with the possible exception that it may prove impracticable to fit it with wireless telegraphy.

Its great speed, however, will enable it to bring back news to a central point without undue delay, and to battle against all but the strongest winds.

It has been objected that, owing to its inability to hover, no useful reconnaissance can be made from it. The objectors, however, neglect to consider two facts:—

1. That when working against the wind, its speed, as compared with the stationary earth, is only the difference between its speed through the air and the speed of the wind against it, and

2. That it can circle round a small radius and thus remain practically above one spot for considerable periods.

INVULNERABILITY

It is extraordinarily invulnerable. The sustaining surfaces may be pierced with many holes without seriously affecting its flight, and some of its main frames may be bruised or even shattered, without involving its destruction, whilst its small size and high rate of travel will render it a very difficult mark to any artillery.

It again must be fought in its own element—the air.

From its cheapness and from the rapidity with which it can be made, it is probable that, if used at all, it will be used in large numbers and will form a scouting machine of the very first importance.

It may also be used to some extent for the same destructive purposes as a dirigible balloon, the small bombs it can carry, and the absence of mechanical appliances for launching them accurately being partially compensated for by the largely increased numbers available for any special duty.

AEROPLANE VS. DIRIGIBLE BALLOON

A very interesting and important question has to be considered, which is, how far can the aeroplane counteract the dirigible balloon?

The present is undoubtedly to the dirigible balloon, but every airship of existing pattern will, in my opinion, be driven out of the field, before ten years are passed, by the aeroplane.

The height to which present patterns of airships can ascend is limited, and these heights will undoubtedly be reached by aeroplanes. I hesitate, however, to say that an aeroplane will be able to ascend to heights of 10,000 feet and over, whilst there is no obstacle to designing airships which can go to 15,000 feet or more. It is merely a question of size.

Within the limits to which aeroplanes can reach I cannot see how a hostile airship can exist in their presence. They are, as mentioned before, very invulnerable, whilst the airship is peculiarly easily destroyed.

It can never pay an airship to attack an aeroplane; it will always avoid it if possible and as its speed will probably be considerably less, it can only avoid it by keeping above it. An aeroplane can probably not ascend at anything like the pace at which a dirigible can, if the latter throws out ballast. Should, however, the aeroplane get above the airship even at a distance it can swoop down on it at a terrific pace without much danger, and would have little difficulty in destroying it.

From 20 to 100 aeroplanes can be built for the cost of one dirigible, so the

loss of two or three would be no great price to pay for the destruction of an airship, which would not be secure from attack even if it remained close to the ground.

As soon, and the time is close upon us, as the aeroplane shows itself capable of raising two men in any ordinary weather to a height of 3,000 feet and of undertaking journeys of 50 to 100 miles with fair certainty, I think that as a mere matter of military precaution we shall be obliged to maintain a very considerable bevy of these vessels, and train large numbers of men to fly and fight them.

Meanwhile we cannot afford to neglect our dirigible balloons and the study of their improvement, so that until an aeroplane is evolved that will ascend to any height and travel over very long distances without descending, we may still be able to enjoy the benefits of aerial strategical reconnaissance, and offence at points far beyond reach of our navies and our armies.

NO ASSISTANCE TO ARTILLERY

I wish to touch on two points, one of which must particularly interest an audience of gunners, and that is the question as to how far these new engines of war will assist the terrestrial artillery.

I fear the answer is "Little, if at all."

At present, aerial observation, when used, has proved itself valuable in obtaining targets and in correction of fire, but this assistance is dependent on two essentials:—

1. The observing station must be fairly stationary.
2. It must be in immediate connection with the officer controlling the fire of the guns.

Neither of these conditions is fulfilled by either the dirigible balloon or the aeroplane.

Captive balloons and kites:

The second point is how the present captive balloons and kits will be affected.

As an instrument of reconnaissance the use of the dirigible balloon or aeroplane will render the captive balloon unnecessary.

As an observatory for the observation of fire the captive balloon will be of use in the presence of an enemy's dirigibles, which I do not think can harm it. It will, however, be unable to keep the air in the presence of aeroplanes used with dash.

The kites, however, are in a different category. They are at their best in winds in which a dirigible balloon is helpless, and in which an aeroplane may find it hard to maneuver.

Moreover they are not easily destroyed by bullets, and an aeroplane would hesitate to charge them for fear of being itself destroyed by the cable.

They might possibly be set on fire, but their uncertain movements would very possibly make an aeroplane chary of coming sufficiently near them to ensure their destruction.

They will, therefore, continue to be of value on windy days both for reconnaissance and for the observation of fire.

SUMMARY

To sum up, I am strongly of opinion that the limited use of dirigible balloons and aeroplanes with an army may be of the utmost assistance to it for:—

1. The collection of intelligence.

2. The moral result on the enemy.
3. The minor destruction of supplies, etc.
4. Assisting the G.O.C.-in-C. to control his troops in battle.

Whilst an extended use of large numbers of these vessels may tend to make warfare more difficult, by the destruction of means of transport, whether on water or on land, and by damage to the factories which supply an army with food, clothing and ammunition, even when situated far in the enemy's country.

DISCUSSION

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GENERAL ARBUTHNOT: General Belfield, ladies and gentlemen, Colonel Capper, our lecturer, has said that this matter must be taken most seriously. I am sure that is an idea which must have struck everyone of you after hearing what he has said as to the importance of this subject.

I have here some information which will be interesting to some of you to show what other nations have done in this direction. I need hardly say that England is behind every other nation either in Europe or America. We always lag behind at the first and come up first at the end, as I hope we shall in this case. (Applause.)

The nation which has taken it most seriously, as you might possibly imagine, is Germany. I dare say you will be astonished to hear that at this present moment the Germans have got sixteen dirigible airships in existence and that in the year 1910 they are going to build six more, the largest of which will have a capacity of 700,000 cubic feet. They are building anchoring places, airship ports and large airship sheds, which shows perfectly, I think, to everyone that they really mean serious business in this matter, and that they no longer look upon it as an experimental science. They have gone into it most thoroughly and they are really doing this enormous work. The total amount of money which has been spent in Germany on airships is £677,500. It is something enormous compared with what we have done; in England the amount spent hitherto in experiments is £12,000 as against £677,500 in Germany.

Russia has voted \$250,000 in their Budget for airship experiments, and France is not far behind. You all know what America is doing by the airships which were shown on the screen.

With regard to England we know that we have got very little chance of getting help from the Government; all these things are left to private enterprise and then the Government takes it up afterwards. It is simply a question of money. The Aerial League has been formed for the purpose of starting propaganda and for instruction and giving scholarships to different Engineering Colleges, and so forth, to induce young men to come forward for experimental purposes.

Theory goes a long way, but the reason that some other nations have gone so far ahead of us is that they have gone into it not only theoretically, but practically, and you will never find that theory without practice comes to a satisfactory result. What we want to do is to get young enterprising engineers to take up the subject practically, and the Aerial League proposes to give them material assistance to help them to carry out their experiments. In that way we hope to arrive at a satisfactory airship made from British designs by British workmen, and not to be dependent on what we may get from abroad.

The Aerial League will shortly make an appeal from purely patriotic

motives for money to enable them to carry out this idea which they have of making the science such as can be entertained by the rising engineers of this country, and I hope the appeal will be responded to in such a way as will enable us to go ahead and keep pace with other nations. (Loud applause.)

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THE LECTURER: Sir, there are a good many questions which have been asked me. I do not profess to be capable of answering them all, but I will be as short as I can in reference to each of them. First, I should like to thank Colonel Stone very much for the kind words he used about this lecture that I have had the pleasure of giving you, and I assure you that it has been a labor of love. I am very much interested, in fact more than interested in the question, I am more or less devoted to it I think, and anything I can study or learn and any help I can get from others on the subject is always very highly valued, and a little encouragement goes a long way.

On the question of reconnaissance I may mention—of course there were no artillery to prevent it—that the “Republique” before she had her smash was used in the French maneuvers, and the rather curious result was that they said the commander of the side that had the “Republique” knew in half an hour more about the position of the enemy’s troops than the commander of the enemy did himself. It is rather a curious thing that it should be so, but of course it was done under the very favorable conditions of not having to be tested with artillery fire.

Colonel Stone’s first question was as to the method of transport of the aeroplanes. I say that the method of transport of an aeroplane is to fly. What is the use of having a thing that is to fly twenty, thirty, forty, or fifty miles after the enemy if it has to be dragged along behind your army? It will go to the base of the army in a ship and from there I hope it will fly forward; that is its proper means of progress, it is its element and it should not require any sort of transport except for petrol, workshop, and so on, unless when broken down. While travelling it should fly about from place to place.

As to starting from the ground, of course I have stated already my opinion that I do not think the present aeroplane is altogether of practical military value for reconnaissance purposes, because it is only in its earliest infancy; they have only just begun to conquer the air, and the question as to whether these machines will be used with starting rails, or with wheels, or what their exact form will be, whether they will be, as Captain Steel asked, helicopters rising straight from the ground, I have not attempted to go into. I cannot say, nobody can say; we may all have our own particular designs which we favor in one way or another, but of one thing I feel certain, that the machines will be capable of starting from very much less area than they can at present, and after all you can nearly always find in any country a bit of smooth ground, and that is the place where the aeroplanist will be able to make for to land; the aeroplanist will go about and find a suitable place to land and for collecting intelligence and so on, even if he has to go back six or ten miles for it, and as long as his wireless telegraph station is there it does not matter a bit. You must get out of your head the idea that small distances are going to be anything to these machines; they will be even less to them than they are to motor cars to-day, and whether you had to go five or ten miles further would be a matter of very little moment. It is not like a division or an Army Corps on the march to which every mile is a very important thing; ten miles will be nothing to them and I dare say fifty or sixty miles will be nothing to them, only an hour or an hour and a half’s journey. I think that rather answers

the question as to whether they can start from the ground and so on. If they meet with accidents they will be fairly helpless, but even motor cars have to be dragged home by horses sometimes.

I was also asked a definite question as to the Government training of aeroplanists, but on that I have no information that I can give.

Colonel von Donop asked a question or two. As to this thing which he calls air sickness, some people get over it easily and some do not. I know the motion of a dirigible balloon from my experience of it, the little I have had, and I must say that I have had some pretty bad pitching, but it is nothing like the pitching of a ship; it is a very much smoother pitching. It may send your heart into your mouth with fear, but I do not think it sends anything else there with other effects. (Loud laughter.)

The facility of observation in dirigible balloons is considerable; it is quite easy to use glasses; there is a little tremor in the ones I have been in, in some perhaps a good deal of vibration, but taking the new model ships—I was up in "La Russie," one of the Lebaudy ships which has gone to Russia, and that was certainly very smooth going, although it pitched a little bit, but there was nothing to prevent you using glasses.

Aeroplanes I have only a very short experience of; I was only up for about two or three minutes, for two or three miles, and I was surprised at the extraordinary smoothness of the motion. There was no sensation of being moved except for the light wind rushing past one.

COLONEL VON DONOP: Could you locate a target or anything from those aeroplanes going at that speed?

THE LECTURER: I think there would be no difficulty if they were far enough off. You must remember that I was skimming the ground then at the height of thirty feet or so, but when you are soaring above the ground at the height of 4000 feet there is no strain in keeping your eyes on an object for some period even although you are moving at a very rapid pace. If you see a distant tree from a railway train you can keep your eyes on it although you cannot look at the telegraph posts along side you.

As to the question of the identification of airships, I am not at all sure that it will be so easy. One difference is that for the coast gunners the ships must always come from certain points. And another thing is that they know where enemies ships are likely to be about, and so on, but I must say that if I had been able to get a photograph—I cannot get it yet because the ship is not out, but we will take the Clement Bayard ship which I believe is coming over to England with a Parliamentary Committee, and ships of the same type, the original Clement Bayard and so on, I think at a great height in the air it would be very difficult, even for the man who had built them himself to know which was which.

With regard to Captain Marriott's remarks I had rather avoided taking an extended view of what these machines may do in future, I rather guarded myself against that, but I do not think I can credit him with the want of imagination I have ascribed to most Englishmen. I think he is perfectly right about the difficulty of identifying dirigibles in the dark, and there is one point about the destruction of the enemy's fleet and that is, that of course I say the only time to destroy the enemy's air fleet is to do it in its own country before it gets the chance of starting. That is the place to attack him; do not wait and defend your own country, but go and attack him before he gets a chance. (Applause.)

Major Baden Powell asked various questions, and there was one as to the probability of the destruction of a dirigible balloon of the French type if the envelope is cut, I suppose by the portion of a shell, which will make a large slit in it. I am afraid that is a considerable danger which can be minimised undoubtedly by dividing the balloon gas bag into compartments, but I think that is a danger that will have to be faced. I have not got at the absolute details that I can rely on as to what happened at the time of the loss of the "Republique," but I saw a French account of what purported to be the result of the Committee of Inquiry, which was to the effect that owing to a sudden leakage of the gas from this rent and the pace at which the balloon was going at the time the head caved in and the front dived down, and such an enormous pressure was brought to bear by the rush of gas on the back part of the envelop that the envelop absolutely tore in half, but at a different point to that at which it had been punctured by the propeller. I am not sufficiently a scientist to know whether that is probable or not, but still it is a danger that has to be faced.

It was also suggested using rockets against airships. I dare say some form of rocket might be used in that way. You might call it a rocket; I take it a rocket is only a shell which goes up by its own motive power instead of being fired out of a gun. I think they are rather erratic; there are some forms no doubt which could be made fairly accurate, but still there is no particular object in having a very large fire to set a balloon on fire; a candle or an electric spark will explode the whole thing just as well as a big fire will do it; so that a small shell, if you can only get it to explode in the right place, will have just as bad an effect on the whole thing as a large powder-holding rocket, and is, I think, more easily directed.

Then there was a question as to the height to which a balloon can go. Of course it is perfectly right to say that the height depends on the amount of gas you can lose. If you have to go up 15,000 feet you have to lose a very large proportion of your gas, and it means you have to have a very large envelope. Going up 15,000 feet is all a question of size; you would have to have a very large balloon indeed, but as the resistance does not increase proportionately to the volume, with a balloon of 2,000,000 feet capacity it would have half its lifting power left, we will say, at the height of 15,000 feet, but you could get, I take it, almost as much, if not as much, speed as out of one of 500,000 feet capacity that can only go to a height of 6000 feet.

Then as to the question of losing your way in a cloud, in one case I think he drew a wrong parallel, and that is the question of a ship in a fog. I would like to ask some of our naval friends, if we have them here, if they are lost directly a fog comes down. That they may go a little out of their way is true, and that a dirigible will go more out of its way because it cannot be sure of remaining in the same wind, is also true; but there is such a thing as a compass which I understand naval people use to steer by at night and in fogs, and I have always understood that the only times you need to go slow in a fog at sea is, one, where you are quite near the coast, and the other, when you are afraid of meeting other ships, but there is no reason, if you knew that there were no ships in the way, why you should not run across the Atlantic at full speed in a fog, or without it, and land somewhere within a reasonable distance of where you want to go.

Speaking of the clouds in a dirigible balloon, I have been above the clouds, and I dare say Major Baden-Powell has been in the clouds himself for two or three hours together. You know relatively the general line you were taking,

and when you came out of the clouds again it was not such a very difficult matter to pick up your direction.

MAJOR BADEN-POWELL: I have not done that myself; I have been entirely lost in that way.*

THE LECTURER: But there I think one is apt to confuse matters a little bit, because you have got no dirigibility in a spherical balloon; with an ordinary free balloon which has no power of its own you cannot tell, although you may have half a dozen compasses, in what direction you are travelling unless you can see the earth. With a dirigible balloon you know that you are travelling at any rate in a certain line. Whether the air currents are travelling in a different direction from point to point you cannot say, but I do not contemplate that you are to stay up in the clouds for a long time; I do not think there is any necessity; I think if you came down once or twice in an hour you might not be very far out of your bearings. Of course it is a matter of opinion and it is a matter of experience.

Then you rather raised the question as to whether you could not make use of a Wright or a similar machine for reconnaissance at present. Well, you might. My opinion is that it is not much use at present, at any rate its use is very limited; even in the hands of men who can manage it very well indeed it seems very much dependent on weather, and so on. I dare say Mr. Orville Wright or Mr. Wilbur Wright or de Lambert might be able to get some use out of it, but I do not think that you can say that at present, within the next year we will say, a Wright machine, given to the army would be of any serious value. I think it is quite possible that they may be used hereafter; they will be improved, but I do not think at the present moment they are of use. As I have stated, it may come sooner or it may come later, in a short time it is possible that they will be of immense value, but I only talk of the thing as I know it to-day. * * * * *

—*Journal of the Royal Artillery, January, 1910.*

The following is part of the discussion upon the above paper, when re-read at the War College, Devonport. Editor.

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COLONEL E. G. NICOLLS, R. A.: I should like to ask a question or two on the offensive rôle of airships. I gather that the lecturer does not contemplate that the aeroplane is going to have any offensive rôle at present; and the carriage of guns or any offensive weapon would be confined to the airship. I think when he said they could do a great deal of damage, the lecturer is expecting too much. He first said they might invent a small gun which would be able to throw a bomb from an airship. I gather that this bomb in shape would follow the lines of a rifled shell, and that it was thought that sufficient muzzle velocity would be got to make good practice at short ranges; but I did not quite follow what you meant by a short range, I gather it is a vertical, and not a horizontal trajectory that you have in mind. We find it difficult now, with a horizontal trajectory, to hit small objects, like dock gates, at great distances. It seems to me that the effect of atmospheric pressure on a projectile will require a great deal of careful consideration, because you will go through a great many layers of air and meet varying winds, which we do not meet with when we get a trajectory practically flat. You say you expect the effect will

* On one occasion I found that the balloon, well out of sight of the ground, had travelled in a direction diametrically opposite to that which it had been taking while below the clouds.

be rather moral than material. Could you give any idea as to what percentage of hits you would expect? Would you get half per cent? I do not think you would get very much more. There must be difficulty in getting anything like accurate practice from guns high in the air.

CAPTAIN L. G. TUFNELL, C.M.G., R.N.: I venture to take part in this discussion for the simple reason that I believe I am one of the few naval officers who have had the opportunity of going through a ballooning course at Aldershot years ago, and carrying out experiments with Major Baden-Powell with man-lifting kites, as well as small ones, to drop despatches on vessels; and I must say that, as far as the navy was concerned, I found that ballooning appeared to me to be absolutely hopeless for this reason, that in the main experiments I carried out as regards the captive balloon, the idea was to see whether it was possible for a destroyer to have a captive balloon, steaming full speed, and to make observations. The way I carried it out on a blowy day was; I went up in a captive balloon about 900 feet at Aldershot; the wagon was then driven against the wind as hard as they could go across Laffan's Plain, and I had a devil of a time. I came down within 200 feet of the ground, and my binoculars were chucked right out, and one could not observe anything; and the pace the horses were going was nothing in comparison with the pace a destroyer could have gone. I found that was hopeless. Then I tried kites. That was all right so long as the weather was perfectly fine and wind steady. We tried sending up kites, steaming along and dropping weights on other vessels as we passed. We then tried going up in kites not quite so elaborate as they have now. Still I tried that in another place, and that was all right in calm weather, with a steady breeze; but the difficulty we found the greatest was the want of space. On board ship there is nowhere to stow a balloon, even the smallest that one could take out; and the difficulty, in the same way, with kites was to get them started, and in altering course. No sooner did we alter course than the whole thing commenced to flatten out. To aeroplanes, which I have taken as much interest in as possible without being able to see them actually flying, I think the same thing applies. The only possible opportunity for aeroplanes to be used with naval work would be supposing we could put one on the fore-castle of a ship, then steam hard as we could to get some lifting power before starting the propeller of the aeroplane. As to whether that would be feasible I should be glad to have the advice of the lecturer. Against that the immense width of the wings is so difficult that I should like to know whether there is any method of reducing the width. I believe one inventor has invented wings which can be folded together, so that, until it is actually wanted for use, the width of the aeroplane is reduced by a very considerable amount. But all observations would be carried out, I imagine, by the military from shore stations and bases; and the only possible use that we could put them to would be for observing the movements of a fleet; and then the only place I can see where they could be used would be on the fore-castle of a ship, and started from three, and I doubt very much whether that would not be found impracticable, because it would certainly hamper the gun fire of the foremost guns; and I doubt whether it would be practicable unless they were folded up.

I should like to ask what the lecturer thinks is the tendency as regards improvements in aeroplanes—that is, as regards speed and lifting power,—in which direction the improvement seems probable? I should also like to ask the size of the cables of kites and the weight for a thousand feet. That was one of the difficulties which in my time we had to contend with.

COLONEL J. G. E. WYNNE, R. A.: The first question that interest all gun-

ners is how to fire at airships or aeroplanes. We have had a certain amount of experience in firing at captive balloons and kites; and I think the lecturer will agree that, as far as a captive balloon is concerned, we can shoot fairly accurately and bring it down in a few rounds. Against the kite we are not so successful, because, although we get a good many hits on it, just in the same way as the aeroplane, it is very difficult to bring down. The holes that the bullets make do not affect its carrying power. The interesting question to us is to know what sort of gun to use against these airships and the nature of shell. Hitherto we have used shrapnel shell with time fuze. It is now proposed to use percussion shell with sensitive fuze, as designed by Messrs. Krupp; but in the British artillery we have no such shell, nor have we any gun like the Krupp gun. I think we should have one like the pom-pom that will fire a certain amount of rounds from a belt, and shrapnel instead of percussion shell, in the belt arranged with time fuze, set at different ranges, so as to burst at distances of 100 yards difference, so that if we got a target at 3000, we could fire a belt of shell at it with fuze bursting from 2000 and 3000 yards. If it was coming towards us, we could possibly get good results.

There is a point as regards percussion shell that might be serious; and that is, if you do not hit the balloon, where is the shell going? You might do your own friends more harm than the balloon and especially in firing in tactical reconnaissance. It is a disadvantage with the percussion shell.

I agree with the lecturer that the artillery will never be able to prevent airships carrying out reconnaissance; and the only thing we can expect to do is to keep them at a distance, to make them fly fairly high, and keep them on the move. If the development of airships, as expected by the lecturer, takes place, it seems to me that not only will the command of the sea be all important, but also the command of the air.

PAYMASTER-IN-CHIEF HARRISON-SMITH, R.N.: The lecturer has referred to the desirability of leaving the air in case of thunder storm. Some years ago, I was serving on the staff of an admiral who thought it was the greatest pleasure in life to go up in a balloon. They went into the clouds, and a storm came on. My friend the admiral thought it would be safer to ascend above the clouds, but the aeronaut thought his way was best and came down, and I think the admiral's way may have been the better one.

MAJOR DYKES: What is the cost of a Zeppelin? Is it not very heavy, and if very vulnerable, will not the two things operate against its use in reconnaissance?

COLONEL RICHARDSON: How do they pack up a rigid Zeppelin so as to transport it?

THE CHAIRMAN: I understood from what you said that the dirigible balloon being so extremely vulnerable was one of the greatest objections to it in addition to others. Do you gather that in time, when the aeroplane improves as it is sure to do, it will completely oust the dirigible balloon, or whether we shall always stick to that for certain purposes? With reference to the vulnerability of balloons, it might be interesting if you would give us the extreme range obtained with the gun of very high elevation designed by Krupp, and also what you imagine will be the probable extreme height that dirigible balloons will be able to reach. I understand you to say it is practically unlimited as long as the size is unlimited? Can a balloon get out of range even of guns designed to damage it?

With reference to aeroplanes taking the place of dirigibles, do you think that the improvements that are bound to take place, would enable it to carry

more than two or three men in addition to the petrol necessary for its own working? With non-rigid dirigible balloons how far would shell such as was mentioned by Colonel Wynne—I imagine he meant a shell about the size of a pom-pom.

COLONEL WYNNE: I should think about 12-pounder.

THE CHAIRMAN: As to the size of the shell that you think will be able to do serious damage to dirigible balloons, whether a 6-inch gun, if we could design one with sufficient elevation and range, would be likely to bring it down?

With reference to atmospheric effect on a balloon as compared with an aeroplane, what effect would a deluge of rain have? The enormous amount of surface it presents, and the materials it is made of, would soak in a certain amount of rain. Would it not so considerably add to the weight as to hamper its movements.

THE LECTURER: I do not profess to be able to answer all these questions. I think some of them are questions on which we have really no sure data to go upon. With a new subject it must always be so.

As to the question of Colonel Nicolls as to the offensive effect of aeroplanes and dirigible balloons, I conceive myself it is quite possible for an aeroplane to carry small incendiary and high explosive bombs, and at night, when my own experience leads me to believe there will be no extreme difficulty on clear nights in finding one's way about country that one knows or has maps of, an aeroplane will get so low that there will be a reasonable amount of chance of putting a bomb on to an object, say, of the size of the deck of a transport. I seriously think there will be no particular difficulty about that. In the same way, about shooting vertically downwards, when I talked about short ranges I was referring to vertical ranges. A height of 2,000 feet is only a range of under 700 yards, and if we test the time of fall of a heavy object from 2000 feet, it is not many seconds; and I conceive it will be reduced largely if we can start it with a considerable velocity. I have no experience myself as to with what degree of accuracy you can drop these. We have certain results of the experiments made in France in the early days, but we cannot get the results of the Germans now, and we cannot make them ourselves. The experience of the French leads me to suppose that we shall reach a very high degree of accuracy. The deck of a ship, or naval buildings, or a manufactory, will not be very difficult targets to hit, but at present it can be only a matter of opinion.

Captain Tufnell made some interesting remarks about his experience with balloons and kites. Of course I do not know, but the idea was to use balloons in the navy, I presume, for reconnaissance purposes, and I have not been alluding much in this lecture to captive balloons and kites; but at Gibraltar we had a balloon attached to a destroyer, (and we have improved since the day when he went through his course), and it was perfectly easy to observe in the captive balloon attached to the destroyer. If you use balloons you must have special ships. I do not think you will be able to use balloons on an ordinary man-of-war. As regards kites, interesting experiments have been carried out in the *Excellent* which have given considerable satisfaction to the officer commanding. I think the Admiralty are not yet using kites for reconnaissance purposes, but we had people up in the air fairly often during the period Mr. Cody was down working with the navy last year.

I was asked some questions about the size of cable. From point 1.85 to point 2.10 in diameter; breaking strain, 2 tons; and weights from 66 lbs. to 83 lbs. per 100 feet. It is a very fine cable. My opinion was also asked as to the use of aeroplanes from ships. I cannot say I am very hopeful until

you get an aeroplane that will lift itself straight up. I understand one is shortly coming out, but none has been seen yet. It is conceivable that there may be room for one of that class on a ship, but I cannot conceive that there will be sufficient room for one as at present designed, nor can I believe that they will be able to get sufficient deck space. I do not know any aeroplane with folding wings which has flown, which is the first duty of an aeroplane. There are lots on paper, but I never knew one get off the ground. As to probable improvements, I think that certainly speed will be increased; but the great improvement that all aeronauts are looking for is automatic stability. The present difficulty of training men is very great. Some of the machines that have done best are those which practically only one or two men have learnt to fly at all. I doubt whether we shall ever train large numbers of men until we get something like automatic stability.

With regard to Colonel Wynne's remarks as to firing at captive balloons, I have every respect for the British gunner, and I would not care to be within range. I dread most the Siege Artillery; their shooting is of marvelous accuracy. When you can put a balloon out and bring it down at the second shot, I don't want to be there. As he says, you cannot damage kites much. Kites are exceedingly difficult to put out of action. One thing that will militate against the ordinary artillery gun damaging dirigible balloons is the question of traverse. All gunners will admit the difficulty if they have to lift the trail. Krupp has made an ingenious arrangement, by which when firing, the wheels for travelling purposes run parallel with the gun axis; they use the wheels at right angles and the trail as a pivot; the change can be made in half a minute. It is very strong and simple.

The worst of shrapnel shell is that, although it may place many bullets on the dirigible balloon, I do not think if it pierces it with a considerable number of small bullet holes, it will do any immediate harm. You will not bring it down with a run, and that is what you want to do. If you get a single hit with fire-breathing shell, you will burst the thing to bits. Even a spark is sufficient to set the whole thing on fire with a bang; and the balloon is bound to be destroyed. A pom-pom shell with sensitive percussion at the end of it, has as much chance of destroying the balloon as a big shell. As to the chance of hitting your own people, I think you can pepper a good deal of country without doing much damage, and, if you hit a few, it is the fortune of war.

As to Mr. Harrison-Smith's remarks with regard to thunder storms, I was up in one an hour and a half. Whether dangerous or not, I did not like it. When lightning came along horizontally at one, nasty barbed forks going from cloud to cloud, 5000 feet up, I thought it was about time to get out. I was fortunate enough to go close to the ground, and another current took me, and I got into fine weather. I had a fellow with me who was making his first ascent, and when we got into this nice weather I said, "Thank goodness we are out of that," and he said, "I am glad to hear you say that. I thought that was the sort of thing you aeronaut fellows like, and I thought no more ballooning for me."

As to Major Dykes's remarks, I believe the cost of a Zeppelin is from £25,000 to £35,000, a mere bagatelle compared with the cost of some vessels. As to transport, the great difficulty with rigid balloons is transport. If the balloon comes to the ground and cannot go up again, it must be knocked to pieces. It is bound to smash up in the long run unless you can get it to pieces and transport it. That is the great objection to using rigid balloons with a field army. The rigid system is the one that will be used for strategical bal-

loons. If you want to attack the heart of the enemy's country, you will use rigid balloons, but where you want balloons to take minor offensive action, you will use the semi or non-rigid, which have gas bags and in case of stress can be taken easily to pieces and transported. A portable shed has been adopted by the French army for maneuvers, but they always had the choice of transport if bad weather came on. A gas bag for a balloon of 100,000 cubic feet would weigh probably under 15 cwt.; the rest probably a ton and a quarter, and, as the balloon has a lifting power of 6500 or 7000 pounds, there is a considerable margin for other things.

General Bowles touched on other questions. The trajectories of guns—the modern English guns—were shown on one slide, but I think you can say that at 6000 yards and a height of 3000 feet, it is practically impossible to hit anything. There is a zone, and at different heights different guns can hit a balloon; but none of our present field and siege artillery can touch you at 6000 yards and 3000 feet high. I do not think myself that any dirigible balloon will ever be maneuvered at 15,000 to 18,000 feet. The question of height is dependent upon size, and I think I can only explain it by illustration.

Having explained his point by means of blackboard illustrations, Colonel Capper said: With regard to the size of aeroplanes, for a long time to come, I think, unless we have the self lifting machines, that will go straight up, the size will be distinctly limited. You ask also as to the effect of rain on airships. Rain will always undoubtedly add to an airship's weight, and unless you can throw out weight to counteract it, will bring it to the ground. It will be one of the troubles an airship will be always subject to. The fabric with which it is made now-a-days is waterproof, but may absorb a certain amount of moisture. There is none that all the water will run off at once, as far as our experiments go. But the Zeppelin, if I may trust the word of gentlemen who have been in it, has been out in very severe rain storms and successfully stayed in the air. You can compensate for increased weight by lifting the balloon itself. For instance, the Zeppelin has in front, and at the rear, planes. If you incline the plane at an angle like that (illustrating) to the wind, you would get an upward lift, and, if it is going forty miles an hour, the upward lift is very considerable, and it might amount to 2 or 3 pounds per square foot of area. If you make those planes big enough, you can temporarily increase the lifting power of the balloon, although you would detract from its pace. There is another method of lifting the propellers so that they will lift you vertically instead of horizontally at any angle; and that will save you having to throw out ballast. (Applause.)

* * * * *

—*The Journal of the Royal Artillery*, February, 1910.

♦ ♦ ♦

AIRSHIP GUNS

The adoption of airships as part of the military equipment of Germany and other nations, and the successful experiments with them, which portend their extensive use, have made it necessary to develop a weapon that could with some hope of success, contend against them.

The guns, or howitzers, now in use are not fitted to meet the requirements. An airship can quickly change its course in any direction, lateral and vertical. They have a speed of thirty miles an hour. And although the large ones offer



KRUPP 6.5 CM. (2.56 INCH) AIRSHIP GUN



KRUPP 7.5 CM. (2.95 INCH) AIRSHIP GUN

a large target, a single shot through one compartment would not seriously damage them.

Fanciful magazine writers have let their pens portray foolish pictures, which should not be allowed to obscure the real service of airships, that is in intelligence work. One need not fear them so much as offensive weapons, but they must be thwarted in their reconnaissance service.

Hence, guns must be developed which shall embody to a great extent the following qualities:

1. Great rapidity of fire,—on account of the difficulty of hitting and the quick movements of the target.

2. High velocities,—which will insure a short time of flight and thus quicker observation of results and rapider firing as well as more accurate firing.

3. Unlimited and rapid training in both elevation and azimuth. All of these ought to insure good percentage of hits.

4. An effective projectile, *i.e.*, one that will cause damage when it does hit.

5. An automobile mount, by which the airship may be followed and the necessity of so many guns of a special type will be avoided.

To fulfill the above requirements, both the Ehrhards and Krupps have developed airship guns.

THE KRUPP GUNS

These are divided into three classes:—

1. Airship gun on field carriage.
2. Airship gun on automobile carriage.
3. Airship gun on ship carriage.

A. The 6.5 cm. (2.56 in.) airship gun L/35 on field carriage.—

This is a barrel recoil gun with liquid brake and spring return. The gun is jacketed. The breechblock is a push-crank block, which drops into place automatically. The trunnions are placed under the breech end of the gun so that loading in all positions is facilitated. In the trunnions are compensating springs, which operate against the forward weight of the barrel and cradle. Elevation is by a toothed arc geared to a handle. Each wheel of the carriage is mounted on a hinged arm of the middle axle, and can be turned toward the muzzle of the gun until its axis is in line with the axis of the spur. Large movements in azimuth are given by running the wheels around the spur as a pivot; small movements by swinging the top carriage, which has a movement of 5° on each side. The carriage can be hooked to a limber or an automobile truck.

The purpose of mounting such a gun on wheels is evidently to make it less of a special gun than one on an automobile. This gun can also be used as an ordinary gun. For data, see Table 1 below.

B. The 7.5 cm. (2.95 in.) airship gun L/35 on automobile.—

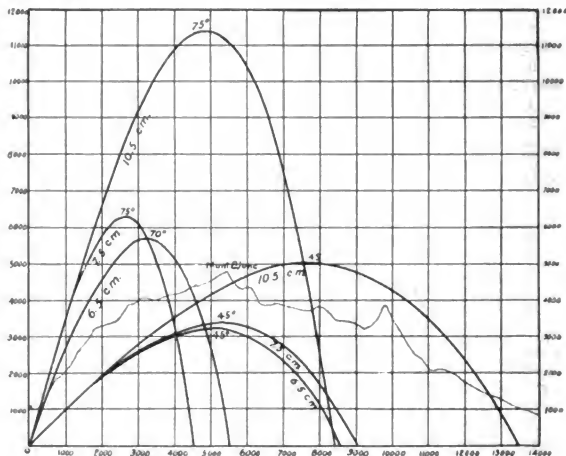
This is either a barrel recoil gun or one that fires as it goes into battery on a middle pivot carriage. It is jacketed and has an automatic, drop, push-crank breechblock; rear trunnions and air compensator; liquid brake and air return; toothed elevation arc; and lateral laying gear, which can be thrown out for quick movement.

The recuperator of the gun that fires on going into battery is under tension in the road-position. On firing, the catch is released, the air expands and drives the gun into battery, at the end of which it automatically fires, and the recoil again compresses the air. The barrel automatically locks in the road, or loading position.

The weight of the automobile (without gun) is 3250 kg. (7170 lbs.), with a mean speed of 45 km. (28 miles) per hour. The motor is one of 50 H.P. The truck carries 62 cartridges. For data as to the gun see table below.

C. The 10.5 cm. (4.14 in.) airship gun L/35 on ship-carriage.—

This is a barrel recoil gun on middle pivot carriage with liquid-brake and 2 spring recuperators on top of the barrel; rear trunnions and spring compensator. There is a seat on the top carriage, and a stand for the sight layer. In other respects, this gun is similar to the 7.5 cm. mounted on an automobile. Data in Table I.



RANGE—METERS.
TRAJECTORIES OF AIRSHIP GUNS.

TABLE I.

GUN	Weight of Barrel.	Weight of Carriage.	Total Weight.	Elevation.	Movement in Azimuth.	Weight of Projectile.	M. V.	M. E.	Greatest Range.	Greatest Height.
	lbs.	lbs.	lbs.	°	°	lbs.	f. s.	f. t.	yds.	yds.
6.5 cm (2."56)	766	1154	1930	-5 +70	360	8.8	2030	25.3	9460	6730
7.5 cm (2."95)	993	1357	2350	0 +75	360	12.1	2050	35.6	9950	6890
10.5 cm (4."14)	3090	3530	6620	0 -75	360	39.7	2300	145.0	14750	12600



KRUPP 10.5 CM. (4.14 INCH) AIRSHIP GUN



FIG. 1. THE EHRHARDT AIRSHIP GUN MOUNTED IN AN AUTOMOBILE



FIG. 2.



DESTRUCTION OF A BALLOON BY EXPLOSION OF A SHOT AND BURNING
OF GAS IN THE BALLOON.

The projectile.—A time-fuse shell is used by the Krupps who claim to have a fuse which is perfectly safe to handle, yet is so delicately adjusted that it will detonate the shell immediately on piercing the hull of the air-ship or balloon. This claim has not been verified and the details of the fuse are not known. The Krupp shell is also provided with a tracer by which the trajectory can be followed by day and night.

THE EHRHARDT AIRSHIP GUN

This is a 5 cm. (1.97 in.) rapid-fire gun L/30 on center pivot carriage mounted in an armored automobile.

The automobile.—This, as shown in the picture is an armored machine with a detachable top; the armor is 3 mm. (0.118 in.) thick of nickel-steel. The gun is mounted in a hood that can be revolved; the port is covered as shown in Fig. 2. The rear part of the automobile forms the ammunition chest which holds 100 pounds. The motor is one of 50 to 60 H.P. The wheels are solid tire and chain driven. A speed of 45 km. (28 miles) per hour is claimed. The automobile reduces the number of special guns by making them easily and quickly transportable, but increases the cost. Yet, this is a rapid fire gun that can be used for other purposes and such a machine may find its uses.

The gun.—The trunnions are placed near the center of gravity. The recoil is regulated by hydraulic brake. Elevation is given by a hand wheel. A shoulder support is used to swing the gun laterally. Open and telescopic sights are used.

The shell has on its base surface 3 revolving toothed wings which swing out in flight and favor tearing the balloon hull.

Chief data.—All round fire; elevation = 70° ; M.V. of shrapnel = 1530 f.s., of shell = 1950 f.s.; range with 43° elevation = 8800 yards; time fuse range = 4750 yards; weight of shell, 3.3 lbs.; weight of automobile, 7,040 lbs.



ARMY AIRSHIP MANEUVERS, 1909.

The importance attached to airship matters in the German army was shown by the extent of the airship maneuvers begun October 28 and concluded November 20, 1909, at Cologne.

Two companies of the Berlin airship battalion and the Metz battalion, their officers and a number of officers from the Kriegsministerium took part.

The airship fleet of the German army consists of the following: *Z I, Z II, P I, P II, M I, M II*; *M III* is about completed and it is expected that *Z III* and *P III* will be taken over by the Government as soon as funds are available. Thus in 1910, Germany will have 9 airships, 3 Zeppelin, 3 Parseval, 3 Gross, or Military,—representing respectively the *rigid, non-rigid* and *semi-rigid*.

Of this fleet, *P I, Z II, M II* and *P III* took part in the maneuvers.

The object of these maneuvers was:

1. To instruct and train the personnel.
2. To practice the airships in maneuvering.
3. To test the airships in:
 - (a) Maneuvering ability,
 - (b) Night trips,
 - (c) Height of traveling,
 - (d) Speed,
 - (e) Distance,
 - (f) Endurance.

4. To compare the different systems.

A full report can not be given, but the following information has been gathered from various sources:

The first day of the maneuvers was used in short trial flights of all the airships, which were very successful.

October 31, a night and distance trip was undertaken by each. The results are reported as very satisfactory, since the ships remained in the air about 7 hours, part of the time in a fog at night. All the ships returned safely to the large hall at Bickendorf, near Cologne, after the trip to Wesel about 50 miles distant. The time of the return flight is given as follows:

P I left Wesel at 4:45 and arrived at Bickendorf at 9:55 A.M.,—5 hours 10 minutes, or about 10 miles per hour.

M II left Wesel at 6 and landed at 11:10, the same time as *P I*.

Z II turned before reaching Wesel.

P III did not take the same course, but left *Leichlingen* at 11:50 P.M. and arrived at Wesel at 4:00 A.M. Returning an intermediate landing of 2 hours, 25 minutes was made. *P II* arrived at *Leichlingen* at 1:25 P.M. Time for returning 7 hours, distance = 42 miles.

November 3, a night trip from Cologne to Coblenz was made. Distance 50 miles. Time: *M II* = 2 hours; *P I* = 2 hours 10 minutes; *Z II* = 3 hours. *Z II* carried 10 persons, *M II* and *P I* each 6. *P II* did not take part.

November 4, *P III* flew twice 6.2 miles in 18 and 21 minutes respectively, average $19\frac{1}{2}$, which makes 19 miles per hour. *M II* flew to a height of 1450 yards and *P I* to 1100 yards.

November 5, a successful long distance trip to Coblenz with intermediate landing was made by all.

November 6, the 4 ships maneuvered together over Cologne.

November 8, *M II* made a trip to Duesseldorf. *Z II* maneuvered at Cologne.

November 15, a 60 mile trip in about $4\frac{1}{2}$ hours was made by *M II*, *Z II* and *P I*.

November 20, *M II* and *P I* returned to Metz. *Z II* remains in Cologne.

While the above notes are incomplete and do not record all the flights, they indicate the kind of work done.

Major Parseval claims that his *P III*, which made daily ascents at the Frankfort Exhibition excelled all the government ships, i.e., *M II*, and *Z II* in these maneuvers in all respects.



AERONAUTICS IN FRANCE AT THE END OF 1909

The Minister of War, General Brun, appeared during the last week before the military committees of the Senate and of the Chamber for the purpose of giving these committees information as to what is now being done in the army and as to what he desires done in the immediate future, in the matter of airships and aeroplanes. The committees desired this information before inserting, in the preparation of the budget for 1910, items for the purchase and maintenance of aerial machines.

Dirigibles.—With regard to these, General Brun stated that last February he had called for bids for airships fulfilling generally the following conditions: Speed, 31 miles an hour; ascensional power from 5900 to 6600 feet; ballast capacity sufficient to maneuver under military conditions. The maximum

capacity of the gas-bag was fixed at 230,000 cubic feet; this was done to avoid the difficulties of getting a sufficient supply of hydrogen for gas-bags of larger dimensions and also to reduce the cost of sheds for housing larger constructions. Two motors were called for.

Two bids made in August were accepted. They came from different houses. Both were for the non-rigid Colonel Renard type. These two ships are now under construction and should be ready before April, 1910.

The two airships *Liberte* and *Colonel Renard* are now undergoing modification. They are to have two motors instead of one; wooden propellers instead of metal; reduced speed of propeller revolutions; special arrangement for protecting the gas-bag from explosion through sparks from the motor.

The old *Ville de Paris* is still able to travel, but as the gas-bag is considerably worn, nothing is being done to it except to keep it in good condition.

Sheds for these various dirigibles have for some time been under construction in the fortified places on the eastern frontier. The one at Verdun is finished; the others will be ready early in 1910.

Aeroplanes.—The Minister stated that in addition to the Bleriot, Farman and Wright machines already bought or which it is expected to acquire, he had called on other constructors for certain modifications which would render their machines useful to the army, for example, the absolute necessity of being able to carry two persons: pilot and observer.

Personnel.—With regard to the organization of the personnel, the dirigibles and the majority of the aeroplanes would be left under charge, as at present, of the Engineers, while at the same time recruiting the personnel from men in the other arms having special aptitude. At the same time a certain number of aeroplanes would be turned over to the field artillery, by reason of the special value which these machines offer for the observation and adjustment of artillery fire.



AERONAUTICS IN 1910

The following is the German estimate of aeronautical statistics for 1910:—

	Dirigibles	Aeroplanes
Germany will have	14	5
England "	2	2
France "	7	29
Austria "	2	4
Russia "	3	6
Spain "	1	3
Italy "	3	7

Besides the three *Zeppelins*, the three *Parseval* and the three *Gross*, there are at present in Germany a *Schoutte* dirigible, a *Siemens-Schukert* and a dirigible called "*Of the Rhine and Westphalia*."

All the other dirigibles are in course of construction. The same applies to the aeroplanes of the Wright type.

In France there are the *Lebaudy*, the *Ville de Paris*, *Liberte*, *Colonel Renard*, *Ville de Bordeaux*, *Ville de Nancy* and the *Clement Bayard*.

Spain possesses the *Espana*: Austria, a *Parseval* and a *Lebaudy* (still uncompleted); a third dirigible of the *Riemfuhr* type is in construction in Austria.

The German budget for the construction of dirigibles is 8 millions of marks (\$1,904,000); that of Austria, \$26,180; that of France, \$227,052.

CORREGIDOR vs. OLONGAPO

It is a well known fact that the United States government is strongly fortifying Corregidor and other islands at the mouth of Manila Bay. While no one doubts that these islands will be put in a condition to be held indefinitely there is much doubt as to the amount of protection which the fortifications will afford to the city of Manila. What degree of immunity from attack will the secure possession of the four or five islands at the mouth of Manila Bay give to the city of Manila 30 miles in the rear of the fortifications?

A well known incident at the siege of Boston during the American Revolution throws much light upon this doubtful point. Every American school-boy knows that the British land and naval forces evacuated Boston when Washington seized Dorchester Heights, a hill on the west side of Boston Bay, and prepared to fire on the shipping in the harbor. The British vessels could have moved to positions beyond the range of Washington's guns but these vessels could not reach the wharves without passing under fire. As the British were unable to dislodge Washington from his stronghold on the hill it would have been necessary for them, in order to continue to hold Boston, to seize another harbor and open communication with Boston by land. They preferred to evacuate the city.

Seventeen years later Napoleon Bonaparte first attracted the attention of his superiors by performing a similar feat at the siege of Toulon. The British land and naval forces held that city. Napoleon captured Fort Aiguillette on a height overlooking the harbor and compelled the British to evacuate the city by bringing a fire of artillery upon the shipping in the harbor. The action of the British both at Boston and Toulon shows that a seaport is a useless prize to invaders if the harbor cannot be used as a means of access to the city. Many other historical examples could be adduced to prove this simple elementary truth. We therefore are of the opinion that fortifications which command the entrance to a seaport and which cannot be captured during the continuance of war afford the most complete immunity from invasion and capture which it is possible to secure by preparation in time of peace. But is it possible to prepare a fortification to withstand successfully a long and vigorous siege?

We are ready to grant that fortified places which can be assaulted by land can be taken. But the case bears a different aspect when the fortifications are upon the islands which contain no civil population to exhaust the food supplies and can be attacked only by the distant fire of artillery or by landing in boats under the fire of infantry, artillery, and machine guns. Military text books inform us that the best protection for a position is a level, unobstructed field of fire over which the assailants must pass to deliver an assault and that a plain is an ideal field of fire. The only perfect plains in nature are water areas. Islands are surrounded by ideal fields of fire. Hence their great strength both in ancient and modern times.

"Positions on islands," says an anonymous writer in a recent number of one of the service journals,* "have been the only strongholds that have ever deserved to be called impregnable. Tyre, situated upon an island one-half mile from the mainland, all but baffled the efforts of Alexander. Ravenna, surrounded by water and marshes, defied every attempt to take it for about 350 years and was taken at last probably through the treachery of its inhabitants. Mantua was taken by Napoleon only through famine. Cadiz, on the island of Leon, which is separated by three hundred yards of water from the

* Journal of the U. S. Artillery, January-February, 1909, page 6.

continent, presented an undaunted front for three years to Napoleon. In our Civil War, the Confederate forts on islands at the mouth of Charleston harbor, separated by channels from one to two miles wide from other islands occupied by the Federals, held out for three and a half years, until the final collapse of the Confederacy. Fort Sumter, an old masonry work on a small well defined island was, indeed, reduced to ruins by artillery fire, but it was held to the last as an infantry position. A wet ditch a mile wide is a powerful deterrent to close investment."

The anonymous writer might have added that, in ancient times, the inhabitants of the little island of Cyzicus in the Propontis, connected to the continent of Asia by only two bridges, withstood the utmost efforts of Mithridates, who besieged it with 400 galleys, 150,000 foot, and a numerous cavalry; and, in modern times, Fort Pickens, on a small island, defied the power of the Southern Confederacy.

Nature was kind to the inhabitants of the Philippines when she placed Corregidor, Caballo, El Fraile, and Carabao at the mouth of Manila Bay. Military genius could not have improved upon the arrangement of islands and channels. The shores of the islands are generally high, precipitous, and unscalable; forests afford the best of concealment for the defenders; the channels can be mined by torpedoes and effectually covered by gun-fire from the islands; and the wide entrance will facilitate the debouchment and deployment, in the face of an active enemy, of a fleet sailing from the harbor and render the operations of friendly brocade runners comparatively easy. The value of the four islands for the defense of Manila can scarcely be rated in money values. Fortunately our military authorities have not weakened the defenses by placing batteries on the mainland at the mouth of the bay. While the island strongholds will not secure absolute immunity from attack for the city of Manila, they provide the greatest possible measure of protection by depriving the prize of all its value to the enemy.

Manila Cablenews-American, November 28, 1909.

Not a little doubt remains in the minds of those who have studied the question as to the finality of the decision of the Washington authorities to abandon Cavite in favor of Olongapo as a naval base.

A naval base is a navy yard on a fortified harbor containing wharves, docks, storehouses, and machine shops for the supply, equipment, and repairing of naval vessels. The best naval bases are at the large commercial ports in the home country, such as New York and San Francisco, where they are comparatively free from attack and have at hand large accumulations of supplies needed for the service of a fleet.

But naval bases are necessary in distant seas for the use and convenience of fleets and armies, and as seats for prize courts in time of war and havens of refuge and refitment for merchant vessels. They must be protected from the fire of hostile ships and the attacks of land forces. With regard to their defense there is one indispensable requirement that must be fulfilled: they must have such natural advantages for defense that they may be securely held in time of war by their peace garrisons, as these garrisons cannot be increased at the outbreak of war. Are these conditions fulfilled by the naval base at Olongapo?

The range of modern ordnance requires that the radius of a fortress on land be not less than six miles in order to furnish protection to the anchorage, storehouses, machine shops, docks, and wharves at its center. This entails

the defense of a land front of approximately 38 miles. It is of great advantage to the defense to place a fortress on a water front in order to diminish the land front, for it is far easier to defend a water front against the attack of ships than a land front against the assault of land forces. Interest in the siege of Port Arthur centers around the land attack; the defense of the water front was so easy that few histories of the siege mention the subject in detail.

An inspection of any good map of Luzon will show that the naval base at Olongapo is more than six miles in the interior of the island. The line of resistance will therefore be not less than 38 miles. It will also be seen by an inspection of the map that the mouth of the harbor is narrow and that positions must therefore be held on the mainland to protect the seacoast guns at the mouth of the harbor required to repel naval attack. We are of the opinion that the main line of defense to protect Olongapo cannot be less than 45 miles in length. Fifty thousand men were insufficient to defend 14 miles of land front at Port Arthur. Comment is unnecessary. We cannot conceive of a position more illy adapted to defend than Olongapo. When the insurrection was at its height the United States did not have one half enough troops in the islands to defend Olongapo against the attack of a first class power.

The best place for a naval station is upon a small island which fulfills the following conditions: 1.—It should be on or near important trade routes. 2.—It should be small enough so that a small garrison can prevent the enemy from landing. 3.—It should have a commodious harbor sheltered from the fire of the enemy's naval vessels.

Such islands are of rare occurrence. Culion, the seat of the leper colony, has been pointed out to us as the only island in the Philippines which fulfills these conditions. It is safe to say that no objections to Culion would have been raised by the military authorities had the navy selected it prior to its occupation by the health authorities. Culion is not far from the geographical center of the Philippines and flanks all important trade routes in the islands at a less distance than is Jamaica from the trade route from the Gulf of Mexico to Panama, for which it has been commended as an excellent seat for a naval base by Captain Mahan. But we hold no brief for Culion. It could in fact be held by a small garrison against the utmost efforts of the enemy, but it would be useless without a preponderance of naval strength. Its fortifications, like those at Olongapo, would of themselves command no important trade route. In this respect both Culion and Subic are radically different from Corregidor, whose guns command the trade routes centering at Manila, and thus fulfill admirably the first requirement for a naval base.

The second condition required for a naval base, an easily defended island, is likewise fulfilled by Corregidor. The third, a commodious harbor sheltered from the fire of the enemy's naval vessels, could be easily brought about by the construction of a breakwater along the reef extending in a circle between Corregidor and Caballo. The works on Corregidor and the islands to the south will give ample protection to the artificial harbor against naval attack. Corregidor must be held for the defense of Manila. By putting the naval base at Corregidor we kill two birds with one stone. If the base were placed at Manila, it would inevitably bring down an attack on the city, which otherwise would not be molested.

A naval base at Corregidor is near enough to Manila to reap the commercial advantages of being near a metropolis but far enough away so that Manila would not be the scene of carnage for the possession of the naval base.

Manila Cablenews-American, November 30, 1909.

A correspondent challenges our conclusions in regard to the fitness of Olongapo as a naval base. From his letter we make the following quotation.

"The power which holds Olongapo and Subic Bay controls Manila. The control of Manila carries with it the sovereignty of the Philippines. A fleet based upon Subic Bay would afford better protection to Manila than a fleet based upon Corregidor and Manila Bay. It is incumbent on the army to devise ways and means for the defense of Subic Bay."

We fully concede the great importance of Manila but we deny that the power that holds Olongapo controls Manila. We deny that a fleet based upon Olongapo and Subic Bay would afford better protection to Manila than a fleet based upon Corregidor and Manila Bay and we say that Olongapo is utterly indefensible.

A naval base of itself is innocuous unless the guns emplaced to defend it command a trade route as do the guns at Corregidor or the forts on the Dardanelles. Naval bases at such places at Guantanamo, Sorsogon Bay, Culion Island, or Subic Bay are harmless unless fleets are based upon them capable of defeating the enemy's navy. The Russian fleet bottled up at Port Arthur gave no protection to Vladivostok. An American fleet bottled up at Olongapo would give no protection whatever to Manila.

It is a fundamental principle of naval strategy that naval vessels capable of taking a place in the main fleet shall not take refuge in any harbor where they are liable to be blockaded by superior naval forces and attacked by land. By violating this principle the Russians lost a fleet at Port Arthur and the Spaniards a squadron at Santiago. We feel confident that our Navy will never take refuge in a fortified harbor. In 1812 it boldly took the sea in the face of a superior navy and won everlasting honor and glory.

Our naval officers today are animated by the spirit of 1812. We know from the writings of Captain Mahan that Dewey's squadron would not have remained in Manila in 1898 had Camara's squadron been able to arrive in Philippine waters in a condition to win a victory, but would have retired toward the main fleet, which would have come to its rescue. Our naval administration has never been guilty of mere shows of resistance to save faces. It has always treated war as a game in which victory inclines to the side of the most skilful.

Again in 1907 when war was thought to be imminent by many worthy people, the Philippines were denuded of all ships fit to take their places in the main line of battle. They all disappeared like birds of passage in the night. We may therefore rest assured that there will always be a period in every war when the defense of our naval base in the Philippines will rest entirely in the hands of the army. This will be followed by the arrival of a fleet capable of contending for the mastery of oriental waters. But this fleet must not upon its arrival find its coal pile in the hands of the enemy. Until it arrives no reinforcements for the army can reach the Philippines. Hence our naval base must be where it can be defended by the peace garrison in the Philippines. During this period American forces fighting for dear life around Olongapo would afford no protection to the City of Manila.

We have already discussed the relative merits of Olongapo and Corregidor. For the benefit of our readers we make the following comparison:

Olongapo.—The land front is about 45 miles in length, which would require a garrison of 160,000 men, if we assume the Russian garrison of Port Arthur as a basis for our calculations.

The Olongapo line of defense can be assailed by artillery of all calibers, small arms, and hand grenades as at Port Arthur and forts can be blown up by mines. Assaultants will engage in hand to hand encounters.

The guns of Olongapo command no trade route.

History furnishes no instance of the successful defense of long lines such as will be required at Olongapo.

Fourteen hundred and seventy-three guns would be required for the land defense of Olongapo, if we assume the Russian armament at Port Arthur as a basis for our calculations. Napoleon's Grand Army began the Russian campaign with 1300 guns.

Under the most favorable conditions Olongapo will never have one-twentieth of the garrison required for its defense.

If, however, the necessary garrison were raised for the defense of Olongapo, troops would serve five years in the Philippines to two years in the United States.

Corregidor.—Corregidor has no land front. It will be more easily defended than Gibraltar, which has a garrison of less than 4,000 men.

Only heaviest calibers of cannon firing at extreme ranges can reach Corregidor. To land on the island the assaultants will have to pass in small boats over four or five miles exposed to the fire of large coast guns, rapid-fire and machine guns, and small arms.

The guns of Corregidor command all trade routes to Manila.

History furnishes many instances of the successful defense of such places as Corregidor.

One-twentieth of the armament required for Olongapo, or 73 guns, would make Corregidor impregnable.

Corregidor will always have its necessary garrison, both in peace and war.

The garrisoning of Corregidor will not alter the present ratio of insular and home service.

We could extend these columns almost indefinitely. From whatever point of view this question is approached, it will be seen that every cent of money spent in Olongapo is throw away. As a station it is of no value unless it has a garrison of over 15,000 men or unless a great fleet is maintained in Oriental waters, both in peace and war, for its protection. Malta has the largest garrison of any existing naval base—about 7,500 men. What was the matter with people who selected a naval base that requires a garrison twenty times as large as that of Malta?—*Manila Cablenews-American*, December 5, 1909.

The question as to the location of the Philippine naval base is a military-naval technical matter that has no connection with Philippine independence. The merits of the case would not be greatly altered if Luzon were a part of the continental territory of the United States. If Cavite, Corregidor, and Olongapo were reproduced, say in the state of Washington, we would still object to Olongapo because it is utterly indefensible by land. We would object to it because its guns command no trade route. As between Cavite and Olongapo, we infinitely prefer Cavite, for it is behind the guns of Corregidor, which will exclude the enemy's navy from Manila Bay, and hence coal piles, drydocks, and stores at Cavite could always be transferred by water to Corregidor out of harm's way. But both Cavite and Olongapo are on the mainland and therefore as sites for naval bases must yield the palm to Corregidor.

—*Manila Cablenews American*, December 10, 1910.

THE BRAZILIAN BATTLESHIP "MINAS GERAES"

The Brazilian battleship *Minas Geraes*, which was handed over to the Brazilian Commission on January 5, having fulfilled every condition of the contract, is interesting primarily as a further proof of the efficiency in design, as well as of construction, attained by our great naval construction firms. In the production of warships leading British firms achieve an invariable success, alike in rapidity of building, constructional strength, and trial performances, which has enabled Britain to maintain for so many years the first place in naval construction. The Admiralty, except on rare occasions, are responsible for the design of British warships, and have generally led the way, although it must be admitted that as the principal requirement of our strategists involves the constant recognition of the principle that "the enemy's coastline must be regarded as our frontier," there must be allowed for in the displacement tonnage of British vessels weights due to claims which are not so imperative in equipping foreign ships. Thus comparisons on paper do not always carry conviction of the superiority of British Admiralty design over foreign warship design, unless regard is paid to such special conditions. In the absence of the crucial test of war, it is, therefore, not always easy to convince foreign critics of our successes, although we have had time and again the flattering compliment of imitation in all essential features. But, in the design of warships for other fleets, under conditions analogous to those which guide foreign interpretation of the compromises characterising the best all-round warship, our great naval construction firms can command recognition of their ability from all the world.

The *Minas Geraes* is a notable example. She embodies the principle of uniformity of caliber in primary armament which distinguishes all modern ships of the line, and as, with moderate displacement tonnage, she has a more powerful armament than any ship afloat, combined with other equally important desiderata, she affords proof of great constructive ability and experience. This is what one would expect from the firm which is responsible for her design and construction, Sir W. G. Armstrong, Whitworth, and Co., Limited, so ably guided in its high ideals by Sir Andrew Noble, who is perhaps our greatest authority on ordnance and explosives, while under him is a staff with broad experience of naval architecture, a fact well established, notably by the efficiency of the Japanese ships during the recent war. With the Elswick firm there is associated in this contract Messrs. Vickers Sons and Maxim, Limited, who supplied all the machinery.

The difficulty of accommodating such extensive gun equipment, while affording the maximum arc of training for each gun, falls upon the naval architect. The weight involved for a pair of 12-inch guns—approximately 500 tons—exclusive of the 9-inch armored walls of the barbette, which add 100 tons, makes it imperative that in action the guns should be of the greatest service. This is the more essential when one also reflects upon the cost of training and maintaining the gun-screws. The engine-designer, on the other hand, makes great demands upon the deck space for his boiler uptakes and engine-room ventilating-shaft. The ultimate test of efficiency rests upon the compromise made between the two claims. In the *Minas Geraes* the two boiler uptakes occupy the minimum of deck area, and the after one is ingeniously arranged in order to overlap, to a certain extent, the two engine-room shafts. Around the uptakes is built a superstructure, on the lower platform of which there is arranged, forward, adequate latrine accommodations for the

men whose quarters are in the main and middle decks below, and aft the cuisine department, with its extensive stores; the upper platform serves as an officers promenade, and around it are hammock-stowing cases, which afford protection against small gunfire. The boats are housed on the top of this superstructure, with the exception of the two "sea" boats, which must always be slung for immediate lowering, as shown on the engraving, Fig. 4. These boats are carried on one heavy double-derrick structure on each side, built up of channels, and braced with transverse channel irons and diagonal bars. These derricks are pivoted at their base, and, by means of the boat-hoists, can be canted outwards to enable the boats to be lowered. The ordinary boats are shipped and unshipped by hydraulic hoists on the superstructure deck and derricks fitted to the vertical member of the tripod mast. On this mast there is carried the gun-control station, with yards for signalling and the aerial telegraph wires. The superstructure essential to boilers and machinery to give a maximum of about 25,000 horse-power thus occupies less than one-third of the length of the ship, and a like proportion of the width.

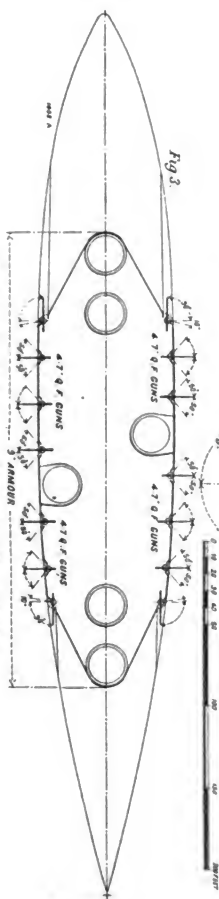
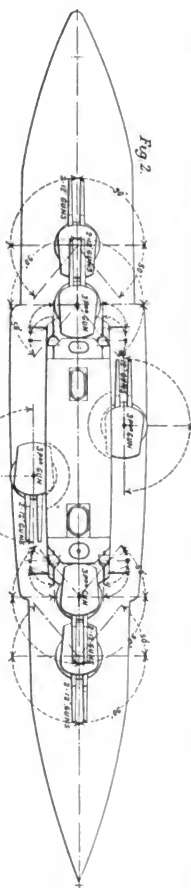
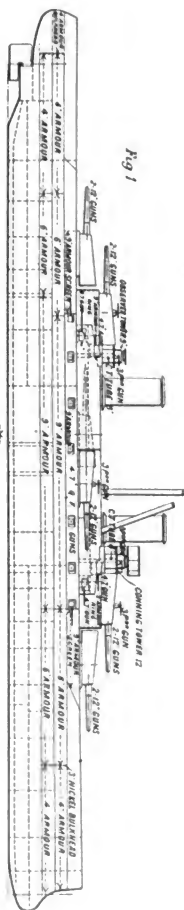
THE DISPOSITION OF THE GUNS

Forward, as well as aft, it has therefore been possible to fit two gun-houses in the center line of the ship, these each accommodating two guns of 12-inch bore and 45 calibers in length. Amidships, on each side, there is a similar gun-house, and in order to allow the immense armor-hood protecting the ordnance machinery to rotate through 180 degrees, the deck structure is cut away in a semi-circle, as shown by the dotted line on the plan, Fig. 2, annexed. Otherwise the upper deck of the ship is free of obstruction. This freedom from obstruction is one of the notable features of the ship, as is shown by nearly all our engravings.

Four of the gun-houses are on the upper deck level (Fig. 1), but the after of the pair of turrets forward, and the forward of the pair of turrets aft, are on a level some 12 feet above these, so that the guns in this case may fire over the guns in front of them (Fig. 4). The centers of the turrets of each pair are about 36 feet apart. Thus eight guns may fire forward, including the four amidships (Fig. 4), eight aft, and ten on either broadside. In this way, it will be recognised, an unusually high proportion of gun-power is utilizable under any conditions of warfare, while the higher elevation of four of the guns gives them a very considerable advantage.

The central superstructure in the ship has been utilized for housing at the forward end, on two different levels, four 4.7-inch guns—two on each side of the bridge—firing forward in line with the keel, with a considerable angle of fire abaft the beam, while aft there are also four such guns similarly arranged (Fig. 1). Six three-pounder guns have been housed in the superstructure, and two others are placed one on the top of each of the higher 12-inch gun-houses, forward and aft (Fig. 2). In addition there are on the main deck, and, therefore, within the citadel of 9-inch armor, seven 4.7-inch guns on each side of the ship (Fig. 3). The upper works forward and aft and indented, as shown in both Figs. 2 and 3, in order that the forward and aft 4.7-inch guns on each side may fire ahead or astern in line with the keel as well as on the beam. There are in all twenty-two 4.7-inch guns.

The broadside fire, therefore, aggregates ten guns firing 850-lb. projectiles, eleven guns firing 45-lb. projectiles, and six guns using three-pounder projectiles. As in each case great rapidity of fire has been ensured, the armament constitutes the most formidable attack yet provided for in any battleship afloat.



FIGS. 1 TO 3. THE BRAZILIAN BATTLESHIP "MINAS GERAES."

THE GUN MOUNTINGS

The mountings for the 12-inch guns follow the most recent Elswick practice, with the exception that, to conform to the desire of the Brazilian authorities, electricity is utilized for the training of the turrets; otherwise hydraulic power is applied, and for every operation there is emergency gear, either of the hydraulic type or for manual working. In accordance with the latest Elswick practice, air-blast is fitted for clearing the gun immediately after each round has been fired; and there is a water-spray on the rammer, which plays upon the obturator-pad immediately the breech is open, to ensure that any sparks then remaining may at once be extinguished.

The guns are arranged to be operated through 18 degrees of elevation, and the gear is so designed that the guns must be loaded at 5 degrees of elevation. The hydraulic power for elevating each gun is normally under the control of the captain of the turret, but for loading operations the main valve is thrown out of gear, so that the gun at once returns to the 5 degrees of elevation, and, having been loaded, is again placed under the control of the captain of the turret for elevation to suit the objective. The recoil is taken up by hydraulic cylinders in the usual way.

The loading machinery has been worked out with the care characteristic of the Ordnance Department at Elswick, and is on the two-stage system, so that there is no possibility of the magazine being jeopardized by any accident at the gun platform. The shell-rooms under each turret are sub-divided, and in this connection it may be stated that a shell-chamber has been arranged between the two engine-rooms. The shells are traversed from their bins by an overhead hydraulic traverser, using toggle-jaw clips, and arrangements have been made so that this traverser can be worked by hand. A circular traversing rail is arranged round the hoist-trunk, and the tray for loading the projectile into the hoist-cage travels with the trunk when the turret is being trained. The door admitting the shot into the cage is interlocked with the cage itself. The charges of ammunition are loaded by hand on the level above the shell-rooms. The charge is put into a hopper in the central portion of the trunk, and falls into the upper tray of the hoist-cage. The cage is elevated by an hydraulic ram working through rope gear to the working-chamber level, where the charge and projectile are driven by an hydraulic rammer into the upper or gun-loading hoist-cage, which travels to the gun-loading position on guide-rails, set to the required curvature. The breech of the gun having been opened, the upper travel of the cage tilts a loading-tray into the breech of the gun, in order to protect the screw-thread of the breech. The rammer in use is of the usual chain type, and its first motion locks the cage, which must consequently remain in position until the gun has been loaded. When the chain-rammer is withdrawn from the breech, the cage falls, and the tilting-tray is then automatically withdrawn. The tilting-tray has a locking -bolt fixed to a slide-arm, which locks the valve of the breech opening and closing motor, so that the breechblock cannot be operated during the process of loading. It will thus be seen that from first to last every action must follow the proper sequence from the moment the charge is put into the hoist at the base of the turret until the gun is loaded and the breech is closed again. The lower and upper cages can be worked by two distinct hydraulic systems, electricity being used to supply the emergency hydraulic power.

The turret is trained by a variable-speed motor, a separate installation of motor-generators being provided in each turret to supply the current and

there are suitable resistances to compensate for the variable speeds required. The worm-wheel is fitted with friction-plates, which are kept up to their work by Belleville springs, so that there can be no shock upon the motor should the training-gear come hard back against the stops on the turn-table roller-path. On the worm-shaft two bevel wheels are fitted for transmitting, through chain gear, the manual power for training the turrets. The electric current for training the turrets is supplied from the main electric installation on board the ship, which includes six generating sets, consisting of Elswick engines and dynamos, the collective electric power being 3600 amperes at 220 volts and 400 revolutions.

There are three hydraulic pumps, in separate engine-rooms—two forward and one aft—connected with one system of pipes, the pressure being 1000 lbs. to the square inch. One of these pumps is practically sufficient to operate the six turrets. Great care has been exercised in connection with the cooling of the magazines, and four of Hall's CO₂ machines are provided, with a collective capacity of 300,000 cubic feet of air per hour—a capacity greatly in excess of that hitherto fitted. This is due to the hot climate in which the ship will usually be serving. Part of this cooling capacity may be utilized in connection with the food stores.

THE ARMOR PROTECTION

A special feature of the turrets is the large space allowed for the operations. The gun-houses seem larger than usual. The side plating is in one piece, while the tops are in two pieces only, with a junction down the center. The front, being 12-inches thick, has had to be made in three pieces, to form the gun-ports. The broadside armor amidships, as indicated on the elevation of the ship (Fig. 1), is 9 inches in thickness for a depth of over 22 feet 4 inches, 5 feet of which is below the normal load water-line. Forward and aft there is a transverse bulkhead, 9 inches thick, enclosing the barbettes (Fig. 3). Forward and aft the water-line belt is reduced first to 6 inches, and then to 4 inches at the ends. The upper strake amidships, extending to the top deck, is also of 9-inch armor, and within the citadel thus formed are the 4.7-inch guns on each side (Fig. 3). There are two protective decks, the water-line deck being 2 inches thick and the upper one 1½ inches thick.

The whole of the armor was manufactured at the Openshaw Works of Sir W. G. Armstrong, Whitworth, and Co., and the 9-inch plates on their trial were subjected to three rounds, the striking energy in each case being 9300 foot-tons. So satisfactory was the resistance to this attack that it was decided to fire a supplementary round, with a striking energy of 10,300 foot-tons. The result of this was exceptionally satisfactory, the penetration in no case exceeding 2½ inches. As, in our issue of August 10, 1908, page 245, we gave the full results of the tests of these armor-plates, there is no need here to say anything further regarding the resisting power of the plates used in the ship.

ACCOMMODATION FOR THE PERSONNEL

Mr. J. R. Perrett, F.R.S.N.A., the naval constructor of the Elswick firm, who has been responsible for the design of the *Minas Geraes*, and who therefore deserves great credit for the increase in gun-power, propulsive efficiency of the vessel, and satisfactory disposition of the ordnance, must also be congratulated on the arrangement of the accommodation for the personnel, for which large provision had to be made.

A study of the complement of the new Brazilian warships shows that the

ratio, as compared, for instance, with British ships, is as 7 to 5. Although this increase may not be proportionately so large in the case of officers, there is the fact that cabins are provided for a larger number of petty officers in the Brazilian Fleet than in the British and other navies. As a consequence, a greater number of state-rooms have had to be provided. All the officers are accommodated aft on the main and middle deck; and, in view of the large range of temperature experienced in South America, special care has had to be exercised to ensure healthy conditions. On both the main and middle decks there is a range of cabins on each side of the ship, and in the middle deck an innovation in warship design has been introduced by the adoption of double cabins, inner and outer.

The public rooms, too, occupy the whole of the intervening space, the cabins opening direct on these public rooms. This was arranged at the instigation of the Brazilian authorities. There are obvious disadvantages with such an arrangement, notably the fact that the officers in the public rooms enjoying social intercourse may disturb the rest of their colleagues in the state-rooms; while it is unavoidable that the companion-ways must lead direct into the public rooms. On the other hand, there is better ventilation, which in the hot climate of Brazil is an undoubted advantage. In addition there has been introduced the thermo-tank system of ventilation, ensuring a constant supply of air, heated or cooled, according to the atmospheric temperature prevailing, to every room and living space in the ship. Another feature is the adequacy of lavatory and bath-room accommodation; indeed, so extensive is this that there is a probability that when the vessel is on service all the ordinary wash-tank basins will be dispensed with, as they are more or less a source of danger to health if the dirty-water tanks are not immediately emptied. There is to be added also the luxury of the barber's shop, with its equipment for chiropody, etc. The sailors' quarters are also in advance of modern practice, and the sick-bays have had very great care bestowed on their location and equipment.

THE PROPELLING MACHINERY

The machinery, which, as will presently be shown, developed a high degree of propulsive efficiency on the trials, has been designed and constructed by Messrs. Vickers Sons and Maxim, of Barrow-in-Furness, who are now completing the sister-ship, named the *Sao Paulo*. The main engines are of the reciprocating type, and their adoption, notwithstanding the experience of the firm concerned with turbine machinery, is a fact to be noted. It is probably due to the desires of the Brazilian naval authorities. * * * *

The economy obtained on trials has been high, the rate on the eight-hours natural-draught power, when the speed was 20½ knots, being 1.6 lb. per indicated horse-power hour. As the *Minas Geraes* will most frequently be run at low power, the cost of maintaining the ship in service will be very low. As regards vibration, the performance of the vessel at all speeds was very satisfactory, a consequence of the long experience of the builders of the machinery. The engines are of the four-cylinder triple-expansion type, and the working parts have been proportioned to balance the couples. The diameters of the cylinders are:—39 inches in the case of the high-pressure, 63 inches the intermediate, and 73 inches for each of the low-pressure cylinders, all having a stroke of 3 feet 6 inches. The distribution of steam is controlled by a single piston-valve in the case of each high-pressure cylinder, double piston-valves being provided for each intermediate cylinder, and flat triple-ported slide-valves for each low-pressure cylinder; the whole of the valves are actuated

by valve gear of the double-bar Stephenson type, and the low-pressure valve-gear is fitted in addition with Joy's patent assistant cylinders. Double-cylinder steam-engines working "all round" gear are fitted for reversing purposes, and similar engines are provided for turning the main engines. All the cylinders are separate and independent castings, each being fitted with a separate liner and steam-jacketed. The cylinders are supported at the front by wrought-steel pillars, and at the back by cast-iron columns carrying the guide-faces. The bed-plates are of cast steel, the shaft bearings being of gun-metal, lined with white metal, and secured by wrought-steel keeps. The crank and tunnel shafting is of forged steel, and hollow.

The propellers are three-bladed, the bosses and blades being of manganese bronze. * * * * The engines are arranged to run inwards when going ahead, the starting-platform being in the center of the ship. One condenser is placed on the wing side of each engine-room. The total cooling surface is 24,000 square feet. The air-pumps are of the independent twin type, and are placed one in each engine-room in the wirgs. This gives a very roomy compartment, with access to all the parts. This is the more satisfactory as a large shell-room and magazine is placed between the engine-rooms.

The boilers, eighteen in number, are of the Babcock and Wilcox latest type, and are arranged in three boiler-rooms, the total heating surface being 58,370 square feet, and the grate area 1686 square feet. The supply of air to the stokeholds is provided by ten steam-driven fans. Weir's pumps supply the boilers with feed-water. Ash-ejectors and the usual ash-hoists are fitted in each boiler-room, and there are air-compressors for sweeping the boiler-tubes and other services. A complete installation of evaporating and distilling plant is provided in each engine-room; while in a separate compartment, on the deck above, two-cylindrical return-tube boilers provide steam for the auxiliary machinery throughout the vessel when the ship is in harbor.

THE DIMENSIONS OF THE SHIP

The following are the general particulars of the ship:—

Length over all	543 ft.
Length between perpendiculars	500 ft.
Breadth, moulded	83 ft.
Depth, moulded	42½ ft.
Draught	25 ft.
Displacement	19,280 tons.
Speed	21 knots.
Normal coal capacity on this draught	800 tons.
Total bunker capacity	2360 tons.

THE STEAM TRIALS

A basin trial was made on May 19, 1909, and preliminary trials of all the auxiliary machinery were also made, all with entirely satisfactory results. The official sea trials commenced on September 14, when a further preliminary trial of the engines and boilers was made under the conditions prevailing at sea. The freedom of the engines from vibration was also thoroughly tested at various powers during these trials.

The forty-eight hours' trial was commenced on September 14, and was finished on September 16. The ship had to steam at about 10 knots for forty-eight consecutive hours, during which the coal consumption and the radius of

action were to be determined. The radius of action was to be not less than 10,000 knots. Six consecutive measured runs on the mile were also to be made—three with and three against the tide—in order to ascertain the speed of the vessel, and the revolutions corresponding to that speed. The evaporators were to be used for making up the loss of feed-water. The steam pressure to be maintained at the engines during the trial was to be about 150 lbs. The trial was run in the North sea, and the six-mile runs on the measured mile at St. Abb's Head. The mean of means speed was 10.623 knots, the mean revolutions 67.28, and the mean horsepower 2683. The speed during the 48 hours was 10.468 knots, the mean revolutions 66.3, and the mean indicated horsepower 2495.

The thirty hours' trial was commenced on September 20, there being two days' delay owing to fog. During this trial three-fourths of the total power—the proportion necessary to give a speed of 20 knots—was to be maintained. All the boilers were in use. Six runs on the measured mile were made, when the mean of means speed was 19.35 knots, on a mean indicated horsepower of 16,353, and 128.26 revolutions. During this run in the North Sea the weather was extremely rough, and very heavy seas were experienced. On more than one occasion the spray washed the upper bridges, notwithstanding that they are 60 feet above the water-line; but throughout the trial the ship behaved excellently, and proved her sea-going capabilities. The Brazilian naval officers were free in their expressions of admiration at the steadiness of the ship in this severe weather test. The mean indicated horsepower for the thirty hours was 16,177, and the mean revolutions 126.9.

After a short interval a further trial of six hours' duration was made to test the oil-fuel installation under working conditions. All the boilers were used and coal was burnt with the oil.

Fog prevented the vessel from going to sea again until September 26. On that day the ship proceeded to St. Abb's Head, where six runs were made on the measured mile, with the following results:—Mean speed, 20.863 knots; revolutions, 138.5 per minute; indicated horsepower, 20,948. The trial was continued until the expiration of the eight hours, the mean speed for the whole of the time working out at 20.762 knots, the mean indicated horse-power being 21,265, and the revolutions 137.85 per minute. These results more than fulfilled the conditions of the contract, although the limitations were exceptionally severe, alike as regards piston speed and air pressure. Heavy penalties were associated with any failure on this as on the other trials.

The vessel completed her steaming trials on September 29. This last trial consisted of six runs on the measured mile, the pressure at the boilers being limited to 250 lbs., with two subsequent runs using steam at 280 lbs. pressure. This, however, was the only limit placed upon the performance of the machinery. The results of the six runs were as follows: Mean of means speed, 21.189 knots; mean indicated horse-power, 25,519; mean revolutions, 146.07. On the subsequent trials, with 280 lbs. pressure, the mean speed was increased to 21.431 knots, the power to 27,212 indicated horsepower, and the revolutions to 147.47 per minute. Table I gives the results of the various trials. In each of the trials the coal consumption was measured, and in all cases came within the specified limit of 2 lbs. per indicated horse-power per hour.

Stopping and starting and circling trials were next carried out to the complete satisfaction of the Brazilian officers. Throughout the trials the ship answered her helm well, two degrees having a marked effect. From first to last the performances showed that, alike in regard to the lines of the vessel,



Engineering.

FIG. 4. VIEW FROM BOW, LOOKING AFT



Engineering.

FIG. 5. BOW WAVE AT FULL SPEED. FROM GUN CONTROL STATION LOOKING FORWARD.



Engineering.

FIG. 6. FIRING FOUR 12-INCH GUNS ASTERN.



Engineering.

FIG. 7. THE FIRST SHIP TO FIRE TEN 12-INCH GUNS ON THE BROADSIDE.



Engineering.

Fig. 8. VESSEL IN DOCK.

the thermo-dynamic efficiency, and particularly the propeller efficiency, most satisfactory results were realized, the designed speed of 21 knots being got under most economic conditions. An eight-hours' completion trial at progressive powers was run off the mouth of the Tyne on November 30, 1909, and everything was found most satisfactory.

* * * * * * *

Fig. 5 shows the water-line at full speed. It is taken from the gun-control station looking forward.

Table I. Results of Steam Trials.

	Speed	Revolutions	Indicated horse-power
48-hours' trial at 10 knots	10.468	66.3	2,495
Average of six measured-mile runs on 10-knots trial	10.623	67.28	2,683
30-hours' trial	19.13	126.9	16,177
Six measured -mile runs on this trial	19.35	128.26	16,353
8-hours' natural-draught trial	20.762	137.85	21,265
Mean of six runs on this trial	20.863	138.5	20,948
Full-power forced-draught trial at 250-lb. pressure, mean of six mile runs	21.189	146.07	25,519
Forced-draught trial at 280-lb. pressure	21.432	147.47	27,212

GUN-FIRING TRIALS

The gun-firing trials were somewhat delayed by foggy weather. When at last the weather cleared they were commenced by firing 3-pounder and 4.7-inch guns. The ship carries twenty-two of the latter, fourteen of which are on the main deck, well protected behind armor, and the remaining eight are on the upper deck and superstructure, protected by large shields. After each gun had been separately fired twice, broadsides were fired from each side. There was no hitch or difficulty of any description; the breeches were easy to work, and the loading was very quickly performed.

The trials of the 12-inch guns were afterwards carried out, two rounds being first fired from each gun in succession. * * * * *

Afterwards five turrets were all trained on the port beam, each gun being given an elevation of 7 degrees and loaded with full charge. These guns were all fired simultaneously, which constituted the heaviest broadside ever fired by a warship. When it is recollected that each gun fired a shot of 850 lbs. weight, and a charge of 285 lbs. of cordite, it will be readily understood what an imposing sight this broadside was. This is the first occasion of the simultaneous firing of ten 12-inch guns on the broadside, as this is the first ship upon which such a performance was possible. The illustration, Fig. 7, is therefore unique; it is a view looking forward.

The sixth turret was used for firing with rapidity and accuracy. Excellent shooting was made in very creditable time.

Another trial of great interest was the firing of one pair of 12-inch guns immediately over another 12-inch turret. Some little apprehension existed in the minds of gunnery men as to the effect that the blast might have on the crew of the lower turret, but the experiment clearly showed that the crew might have remained in their turret, and have suffered no inconvenience what-

ever, in spite of the large guns being fired at a distance of only 4 feet or 5 feet above their heads. The heavy roof of the lower turret was proved to be an ample protection, and in no way suffered from the explosion above it. This trial evoked so much interest that representatives from foreign countries had obtained special permission to come on board and witness it.

Fig. 6 will be studied with care by those who thought that the placing of the two pairs of guns at the forward and after end, within 36 feet of each other, on the same fore and aft, would result in the flash from the forward pair interfering with the aiming of the after pair. The view in Fig. 6 shows the four guns at the after end firing in the same bearing astern. In the foreground there is the smoke from the after funnel, but the port gun in each pair is easily seen. The views in Figs. 6 and 8 afford sharp contrast between war and peace conditions.

In the *Minas Geraes* a new system has been fitted to ensure that the guns cannot be fired into any of the fittings of the ship. A careful test of the system was carried out, and it was proved to be thoroughly efficient.

THE CONSTRUCTION OF THE VESSEL

These results establish what we have said at the beginning of our article, and prove the success of the design, since the conditions specified by the Brazilian Minister of Marine have been fulfilled in every respect, with a large margin. Nor must the period of construction be omitted. In this work the two firms of Sir W. G. Armstrong, Whitworth, and Co., Limited, and Vickers Sons and Maxim, Limited, have combined, and the Brazilians in obtaining this co-operation have secured a professional experience which is without parallel. The two firms have done more work in the building of modern battleships than any other two establishments in the world, and, moreover, have the capacity for the construction of every unit which goes to make up a battleship of to-day. It is true that the *Minas Geraes* has occupied about two years and six months to build, but within that period there was on the Tyne a strike of five months' duration, which greatly delayed the work, so that if we reckon working time alone, the vessel has been built within two years. A similar performance has been achieved in connection with the *Sao Paulo*, which is being completed at the Vickers Sons and Maxim Company's Works at Barrow-in-Furness. It has to be borne in mind, moreover, that this performance has been achieved notwithstanding that there have been in process of construction simultaneously in these two works five ships of the line, of the *Dreadnought* type, a record, which has no parallel with any two other firms. At the same time, also, the two firms named have been engaged in the building of the guns and gun-machinery, not only for these ships, but for several others for the British and foreign Governments, and yet their resources have not been taxed to anything like their full capacity. At the present time, when the relative capacity of Great Britain and certain foreign countries for the construction and equipment of war vessels is deservedly attracting so much attention, these facts have a very special interest.

* * * * *

—*Engineering*, January 21, 1910.

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SEARCHLIGHTS: OTHER MEANS OF ILLUMINATION AND TELEPHONES AT PORT ARTHUR*

I. DISPOSITION OF THE SEARCHLIGHTS

There were 12 electric lighting installations in Port Arthur, six for the land front and six for the sea. Three of these were taken from ships in the harbor.

There were disposed as follows (see sketch page 190.):—

Sea Front

1. Summit of Liaotieshan	90 c.m.
2. Liaotieshan Lighthouse (naval light)	
3. No. 4 Battery	90 c.m.
4. No. 9 Battery	40 c.m.
5. Electric Cliff Battery	90 c.m.
6. No. 22 Battery	90 c.m.

Land Front

1. No. 1 Fort	90 c.m.
2. No. 1 Earthwork	75 c.m. (naval)
3. No. 2 Fort	90 c.m.
4. No. 4 Fort	90 c.m.
5. No. 5 Fort	75 c.m. (naval)
6. No. 5 Earthwork	90 c.m.

II. NOTES ON THE LAMPS AND PLANT

Electric Cliff and No. 22 Batteries, as well as Forts 1 and 2, had Schuckert arc lamps. The projector of No. 4 Battery had a Kutscherow arc lamp. In all these lamps the carbons were controlled automatically by an electro-magnetic mechanism. The power was supplied by 10-H.P. Nobel steam engines and Derozier dynamos, which supplied 80 amperes at 100 volts.

No. 4 Fort, No. 5 Earthwork, and the Liaotieshan Lighthouse had automatic Schuckert arc lamps, with Nobel petrol motors and Derozier dynamos.

No. 9 Battery had a 40-cm. hand-worked arc lamp, with a movable steam engine and Siemens dynamo of 40 amperes and 60 volts.

No details are known of the three naval lamps at No. 1 Earthwork, No. 5 Fort and the summit of Liaotieshan.

III. RANGE OF THE LIGHTS

Experience showed that the range of the lights was as follows:—90-cm., 5 to 6 kilometers over sea; 40-cm. (naval), up to 3 kilometers over sea; 75-cm. (naval), no figures were obtained, as this light was used over land.

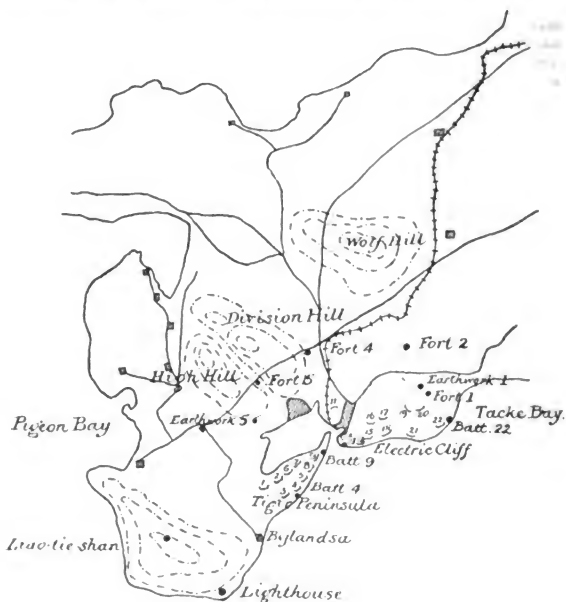
IV. THE GENERATING PLANT

The steam engines worked badly and often stopped altogether. The boilers had to be cleaned out every Monday, as the water used was hard and dirty. The Japanese had destroyed the waterworks, and the fresh water obtained from the filters was barely sufficient for the garrison. The petrol motors were old and had many breakdowns.

* Translated from the *Mitteilungen ueber Gegenstaende des Artillerie- und Geniewesens*.

V. THE SEARCHLIGHTS ON THE LAND FRONT

The searchlights on the land front at Port Arthur had very exposed positions. As this allowed of their being easily destroyed, especially by any assaulting party, some expedient had to be adopted which would not only give the searchlights cover, but also enable them to illumine the ground close to the fortress. This was done by using tin-plate reflectors, on to which the beam



Note. • - Searchlight.

of light was allowed to fall. The light itself was placed in a hollow, often with its back towards the attacker. This system was only used when the attack came close to the lights.

The absence of Iris shutters to shut off the light was found to be most inconvenient.

VI. THE LIGHTS ON THE SEA FRONT

There was no uniform control of the lights. An officer was allotted to each light, both to superintend the personnel and to observe any passing ships.

The officers were, however, too independent of one another, went to work without any fixed system, and were not in communication with one another.

So as not to show up the guardship behind the boom, the lights of Nos. 4 and 9 Batteries had orders to search from the left up to the boom, and Electric Cliff light, from the right to the boom. All the other lights had to search the sea in front of them as follows: Starting at their maximum depression, they swept from one limit to the other, then elevated a bit and came back, and so on, until the maximum elevation was reached. Thus the whole sea in front of the light was searched from quite close to the light to the limiting range. When a target was discovered the neighboring lights were also directed on to it, partly to render its forward progress difficult by blinding the steersman, and partly to show it up to the guns. When several targets were discovered, the lights divided them up amongst themselves.

The light on Liaotieshan could not co-operate with that of No. 4 Battery, as its position only allowed it to illuminate the sea to the west and south-west of Liaotieshan.

VII. THE DESIRABLE NUMBER OF LIGHTS AND THEIR DISTRIBUTION

As can be seen by looking at the sketch, the large portion of sea to the S.W. of No. 4 Battery could only be illumined by the light near that battery, which also had to search the sea to the S. and E. of its position.

As has been already mentioned, the Liaotieshan Lighthouse projector could only illumine the sea to the W. and S. of its position, and, moreover, the beam on the top of Liaotieshan could only light up Pigeon Bay and the sea to its west. Thus a light at Bejlandsa village would have been most desirable, but unfortunately could not be obtained. It is however hard to understand why a searchlight from one of the ships lying useless in the harbor could not have been installed at Bejlandsa. Subsequently these lights went down with the ships they were on, and were thus lost. How useful such a light would have been was shown in the night 23rd-24th February, when two Japanese fireships came up unobserved from the south of Liaotieshan along the coast in the dead water of No. 4 Battery light up to the water opposite No. 5 Battery, when they were discovered by No. 9 Battery whose searchlight at this period was however not in working order.

Takhe Bay could only be occasionally lighted up by the beam of No. 22 Battery, and even this was not sufficient as there was dead water in the west of the bay. Probably it is due to this circumstance that the Russian torpedo-boats, *Lieutenant Burakow* and *Bojewoj*—which were on night duty in the bay—were destroyed on the night 23rd-24th February by Japanese torpedo-boats, which had crept unperceived along the coast.

No. 9 and Electric Cliff Battery lights could render but little assistance to No. 4 Battery light, as they had to form a "light obstacle" by crossing their beams. As they had however occasionally to search in other directions, the "light obstacle," or "illuminated area," was not continually in position. The efficiency of this "light obstacle," which was intended to blind attacking ships, was tested by Admiral Makarow himself in a tender and proved entirely successful, as the tender lost its course and was wrecked near Electric Cliff.

From the above it will be seen that the number of lights used was insufficient.

Roughly, considering the range of a 90-cm. projector as 5 kilometers, the number of lights required can be obtained by dividing the length of coast to be defended by five. Provision must however also be made to illumine all bays

and other parts of an irregular coast line. The lights intended for the "illuminated area" should have no other object and should be fixed. Other lights should be movable, or the enemy will make use of a knowledge of their position to steer by, as was here found to be the case from a map captured from the Japanese.

If the lights are not movable, they should be so numerous that alternative ones can be used, so that the enemy is deceived, and yet the illumination is the same.

For the "illuminated area" four lights are best, two in action and two in reserve. Experience showed that the best position of the lights was to one side of and below the battery. Observation from a point above the beam was found to be infinitely better to that from a point below it.

When batteries are situated so low that there is no possible position for a projector below them, the light should be placed well on one side of them.

VIII. CONTROL OF THE LIGHTS

When the number of lights is so great that each battery can have its own beam, it should be controlled by the battery commander. When this is not the case, the lights should be allotted to groups of batteries, and each light placed under the orders of the commander of the group.

The supreme control of the coast defense lights lies in the hands of the coast defense commander, who should be a coast artillery officer. The coast defense commander issues orders and instructions relative to the working of the lights when the enemy has been discovered, and draws up the scheme of changing the lights to deceive the enemy. When he orders a battery or group of batteries to open fire, he hands over to its commander the control of the lights allotted to it.

At Port Arthur there was unfortunately no such centralized control of the lights. The lights were not connected by telephone, and acted either independently or under the command of the commander of nearest battery, who directed them by means of signals on an electric bell, *e.g.*, one ring = swing right; two rings = swing left, etc.

Some of the lights were also occasionally placed under the command of the naval squadron commander, who was on board the battleship *Sebastopol* in the Eastern Harbor up to 10th August. Again, it often happened that torpedo-boats returned the same night as they went out. As however nobody but the admiral and naval officer of the day knew the secret signs they were to give to show they were friendly, the batteries had to remain undecided whether to open fire or not until the sign had been obtained from the naval officer on duty in the harbor, and much valuable time was thus wasted. It is believed that the Russian torpedo-boat *Silnyj*, which was destroyed on the occasion of a Japanese fireship attack, was probably sunk by Russian batteries, which had no means of readily distinguishing friend from foe.

IX. A SUGGESTED MEANS OF MAKING USE OF AN UNILLUMINATED ANGLE

The following suggestion was made at Port Arthur, but was not put to a practical test:—

Two neighboring lights agree only to light up to definite limits, so as to leave an unilluminated piece of sea between them, in which one or more torpedo-boats assemble. As soon as a hostile ship appears they make for it, taking care however to remain in the dead angle. On reaching a suitable range, or on being discovered, the torpedo boats open fire. If they are unsuccessful,

they show their lights, send up a rocket, and return to harbor, whilst the coast batteries open fire on the target.

X. MEANS OF ILLUMINATION FOR NIGHT WORK OF THE FORTRESS

In Port Arthur these consisted solely of petroleum lamps or candles, which were both inconvenient and inefficient, and further led to several accidents in the darkness.

XI. TELEPHONIC COMMUNICATION

The telephone lines in Port Arthur belonged partly to the artillery and partly to the engineers. Owing to lack of *personnel*, only some of the lines could be used.

The communication was very bad, and men were often seen running from one telephone station to another carrying messages. A battery had often to ring up several exchanges to get into communication with one of its "observation instrument" cells, and as one line was often used by several batteries, each had to wait its turn—perhaps for 30 or 35 minutes.

All telephone wires were carried as air lines, and were often cut by shells or inimical Chinese. There were no special "command lines."

—*The Royal Engineers Journal*, December, 1909.



THE BATTERY COMMANDER'S INITIAL CORRECTION AS REGARDS RANGE

By Lieutenant C. R. GILLETT, R. A.

Although an initial correction of some sort has always been necessary, we have only lately been provided with range tables that give us information on those points that will affect the shooting of our guns.

The following notes will explain the various calculations necessary for this initial correction, and it is hoped that they will be of use to those officers who have not had a chance of studying the subject.

Firstly, we will divide our initial correction into three separate headings:—

- I. Interior Ballistics.
- II. Exterior Ballistics.
- III. Variables during day.

Now the following information will have to be obtained as regards I.:—

(a) M.V. the elevation indicator and cam are made out for, this will be found stamped on them.

(b) M.V. of the gun from last calibration or M.V. of a new gun, this information can be got from the range table.

(c) Number of rounds fired (equivalent full charge) since last calibration or total equivalent full charge rounds fired during the gun's life, this can be obtained from the Memorandum of Examination.

(d) The number of rounds that cause a decrease in M.V. of 10 f.s. which is given in the range and elevation scales of the gun in question.

(e) Temperature of charge. This should be obtained by leaving a thermometer in a cartridge for ten or twelve hours at least.

(f) Temperature of charge for which the range table is made out, which is printed on the first page in the majority of range tables.

(g) Effect of $\pm 10^{\circ}\text{F.}$ from temperature (*f*) on the M.V., which information is given in a note at the end of the range table.

(h) Weight of shell, all shell should be weighed prior to practice.

(i) Yards due to change of 10 f.s. M.V. shown in the corrected range table, col. 5.

As regards II., the following information is required:—

(a) Barometer at M.S.L., this should be obtained from the standard instrument in the command.

(b) Thermometer readings of the wet and dry bulbs.

(c) Table VII. from "Tables for use with Text Book of Gunnery."

(d) Weight of shell.

(e) Yards due to a change of 10% in the ballistic coefficient, which will be found in the corrected range table, col. 6.

And finally as regards III the various headings on the attached B.C.'s. Initial Correction Form need no explanation.

Now the above list may appear formidable, but when seen on the form attached, the various items can be quickly filled in.

This B.C.'s form is designed and arranged so that it can be printed on three cards hinged together to allow the whole form to fold up and fit in the breast pocket, the actual information printed on them should be that information which is printed in light type, and wherever necessary there is sufficient room for calculations concerning three guns of the same nature; if more guns, or guns of a different nature are under the same battery command, then a second form would have to be used.

Space is also given for necessary corrections to be worked out at four different ranges, as unless the opening range is known, a correction curve is a necessity.

The actual information printed on the card requires no explanation, the card being divided up into the three headings already mentioned, and besides have one space for the grand total and another space printed in squares so that the B.C. may draw out his own curve.

I will now go on to the calculations necessary for filling up this card and for arriving at an initial correction which should bring the first round within the 50% zone.

The ranges employed to work the curve on in the examples that follow are 3000, 6000, 9000, and 12,000, and the gun taken is a 9.2-inch Mark X. on Mark V. mounting.

All figures are more or less bogus so as not to give confidential matter out of the range table.

Now taking I., Interior Ballistics, we subdivide this up into three sub-heads:—

(a) Wear of Gun.

(b) Temperature of Charge.

(c) Weight of Shell.

These three are worked out separately for alteration in M.V., and finally the total alteration in M.V. is converted to yards at the four ranges above mentioned.

Now taking (a) Wear of Gun.

We find in the range and elevation scales that fifteen rounds cause a loss of 10 f.s. M.V., and we find from the Memorandum of Examination that the gun has fired seventy-five equivalent full charges.

Thus a loss in M.V. of 50 f.s. may be expected.

Now the M.V. marked on the range indicator and cam should be ascertained, and if this M.V. is found to differ from the M.V. of a new gun the difference must be taken into account.

Thus if the M.V. on the range indicator is 2950 fs., and that of a new gun 3004 f.s., as we have taken our correction for wear from the total number of rounds fired we must subtract it first from the M.V. of a new gun and then compare it with the M.V. marked on the range indicator.

Thus 3004 f.s. — 50 f.s. = 2954 f.s., so that we actually have a gain of 4 f.s. M.V., this of course is often the case with a new gun when the range table has been compiled from practice with a worn one.

In the case of calibration, the M.V. found would be substituted for the new gun M.V. and the number of rounds fired since that calibration would alone be taken for calculating additional wear.

(b) Temperature of Charge.

This correction is necessary owing to the fact that the expansive power of the gases given off by cordite vary with the temperature of the charge; thus if the temperature of the charge is greater than that for which the range table is made out, then the power of the charge is increased and an increased M.V. may be expected.

Nearly all range tables have the temperature of charge, at the practice from which they are compiled, printed on them, but in the case of no such information, the range table has been calculated for 60° F.

Continuing our example we find the 9.2-inch Mark X. range table is made out with a temperature of charge of 80° F., and in the notes at the end of the range table we find that $\pm 10^\circ$ F. alters the M.V. by ± 7.9 f.s., so that if in our example the thermometer reads 60° after having been removed from the cartridge, we would expect a loss of M.V. of 15.8 f.s. due to drop of 20°.

(c) Weight of Shell.

The shell should be weighed before practice and in most cases is of correct weight or can be made so, however if not the variation in M.V. to be expected may be worked out by Ingall's formula.

$$\frac{\Delta v}{V} = \pm \frac{7}{16} \frac{\Delta w}{W} \text{ where } V = \text{Range Table M.V.}$$

W = Standard weight of shell.

Δv = Change in M.V. to be found.

Δw = Alteration in weight of shell.

Thus if our 9.2" shell weighed 382 pounds.

$$\begin{aligned} \text{Then } \frac{\Delta v}{2700} &= -\frac{7}{16} \times \frac{2}{380} \\ \Delta v &= -6.2 \text{ f.s.} \end{aligned}$$

for as the shell is heavier than standard the charge will have to overcome more weight and consequently there will be a loss of M.V.

So that now, as regards Interior Ballistics, we have the following results:—

Alteration in M.V. due to wear	= + 4.0 f.s.
Alteration in M.V. due to temperature of charge	= — 15.8 f.s.
Alteration in M.V. due to weight	= — 6.2 f.s.
Total	= — 18 f.s.

Now from the corrected range table we find the value in yards of a change in M.V. of 10 f.s. at the various ranges chosen, and by a simple calculation, the effect of — 18 f.s. M.V. can be easily arrived at.

We now proceed to II. Exterior Ballistics.

This can be subdivided down into two subheads, viz.:—

(a) Alteration in Air Density.

(b) Weight of Shell.

Taking (a).—The causes that affect this alteration are the respective readings of the barometer and the wet and dry bulb thermometer.

The range tables are made out under the following conditions:—Barometer 30", Thermometer 60°, Humidity 66.6%, which is equivalent to a wet bulb reading of 53°, and with these conditions $T = 1.000$.

By using Table VII. "Tables for use with Text Book of Gunnery," we can find the relative state of T for various readings of barometer and the wet and dry bulb thermometer.

Thus, supposing the barometer reading at M.S.L. was 29.75 and our battery was 500 feet high, we would have to calculate the height of barometer at half this height, being the average height of the projectile's path, the range table is already corrected for the height of the trajectory above the line of sight, we, therefore, have a height of 250' above M.S.L. to allow for, so that the corrected reading would be 29.5", for the barometer reads 1" less every 1000 feet up.

Now taking our wet bulb as 65 and our dry bulb as 72°, from Table VII. we get the following:—

$$\begin{array}{l} \text{Wet bulb } 65 \} \\ \text{Dry bulb } 72 \} \end{array} \begin{array}{l} \text{barometer } 29.5 \} \\ \text{ } \end{array} \begin{array}{l} 503.6 \\ 8.7 \end{array}$$

$$512.3 = 8$$

$$T = \frac{8}{\Delta} = \frac{512.3}{534.22} = .959.$$

That is the air density under the conditions taken has decreased by 4.1% from normal or range table density, and as the air is rarer than unity the tendency of the shot will be to range over, and a minus correction is necessary, for the ballistic coefficient has been increased by 4.1% for T is in the denominator of the ballistic coefficient.

Now as regards (b) Weight of Shell.

To continue our example the shell weighs 382 lbs., this then is an increase of 2 lbs. in 380, which is equivalent to an increase of .53 in 100. That is an increase of .53% in the ballistic coefficient for W is in the numerator of the ballistic coefficient.

Thus we have as regards II.:—

$$\% \text{ change in } C \text{ due to weight of shell} = + .53$$

$$\% \text{ change in } C \text{ due to air density} = + 4.1$$

which gives us a total of + 4.63%.

Now in the corrected range table, col. 6, we find the values of a 10% alteration in C at all ranges, and from this the effect of a 4.63% alteration can be easily arrived at for the four ranges chosen.

N.B.—An increase in the ballistic coefficient requires a minus correction.

We now come to III. Variables during day. First we will take (a) Wind.

The effect of wind on a projectile's path was given by Major Dykes in an article in the "Journal of the Royal Artillery,"* and can be calculated by his formula $\frac{wt}{3} - A$. the formula is so well known that explanations are unnecessary.

I attach a wind scale that I made out for myself and have found useful.

* "Wind Up or Down the Range," Vol. XXXIII., No. 8, November, 1906.

(b) Travel.—This is a most important correction with a rapidly approaching or retiring target and can be calculated by the simple formula.

$$\frac{\text{yards in 10 seconds} \times \text{time of flight}}{10}$$

The D.R.F. or P.F. can ascertain the yards the range has shortened or lengthened in ten seconds.

(c) Tide.—The correction necessary for a rise and fall of tide should be worked out for each battery, *vide* "Garrison Artillery Training," Vol. I.

The formula is

$$\text{Correction} = \frac{f}{\tan(a + \theta)}$$

where f = difference from M.S.L.
 $(a + \theta)$ = angle of arrival.

(d) Time of firing.—This is of course unnecessary with auto sights, and with well trained detachments should not be necessary either. It can be calculated in the same way as Travel.

(e) Errors in range finding or finder.—Before correcting for this possible source of error the B.C. should satisfy himself that a correction is necessary either owing to the instrument being out of adjustment, or through the idiosyncrasy of the observer, which would result in the range finder giving a false angle of depression.

The formula for this error is

$$\text{Correction} = \frac{n \times 8.7 \times r^2}{h}$$

(f) Mean point of impact.—The B.C. should bring his M.P.I. to the center of the total P.E. and a correction for this will certainly repay him.

To find the correction necessary, the following formula may be used:—

$$\frac{\text{P.E. (total)}}{2} - (\text{P.E.}) \text{ gives yards } + \text{ correction required.}$$

(g) Possible errors in passing ranges. This correction is to counteract the unavoidable error of the gun being laid and fired just before the range reaches the next 25 yards on the dial; this correction would never be greater than ± 25 yards. It would of course be unnecessary with auto sights.

Theoretically (a) and (e) of III. should be multiplied by $\frac{a}{a + \theta}$ but this may be disregarded, and the corrections for I. and II. have been taken from the corrected range table, which is corrected for this difference.

Finally, it is useful to note that the following conditions make the gun shoot short and consequently a + correction is required.

- I. Loss of M.V. due to wear.
Decrease in temperature of charge.
Increase in weight of shell.
- II. If T is greater than unity.
Decrease in weight of shell.
- III. Wind blowing towards the battery.
Target steaming away from battery.
Rise of tide.

BATTERY COMMANDER'S INITIAL CORRECTION FORM.

I. Interior Ballistics.

M.V. { Indicator = 2950 f.s.
 { Cam = 2950 f.s.
 M.V. or new gun = 3004 f.s.

Wear 15 rounds = loss of 10 f.s.

Charge Temp. R.T. = 80°

Temp. of Charge = 60°

± 10° = ± 7.9 f.s.

— 20° = — 15.8 f.s.

Weight of Shell = 382

Δv = — 6.2 f.s.

Gun	rounds	Δv
A/1	75	+4 f.s.

Total Wear, Temp., Wt., = — 18 f.s.

Range	3000	6000	9000	12000
10 f.s. =	40	60	80	100
— 18 f.s. =	+72	+108	+144	+180
f.s. =				
f.s. =				

II. Exterior Ballistics.

Barometer at M.S.L. = 29.75

Corrected at half height = 29.5

Thermometer { Wet Bulb = 65
 { Dry Bulb = 72°

T = .959 = + 4.1% Change C

Weight of shell = 382 = + .53%
 Change C

Total = + 4.63% Change C

Range	3000	6000	9000	12000
10% =	20	80	280	440
4.63% =	—9.3	—36	—130	—205
% =				
% =				

III. Variables During Day.

(a) Wind 40 f.s. at 2 o'clock.

(b) Travel 50 yards in 10 seconds.

(c) Tide 8' rise.

(d) Time of firing nil.

(e) Errors in range finding + 1 minute.

(f) MPI for Target 30 × 60 × 200 and 100% Zone.

(g) Possible error in passing Ranges — 25.

Range	3000	6000	9000	12000
a	+6.8	+27.2	+58.8	+102.6
b	—19	—44	—74	—111
c	+75	+50	+25	±0
d	nil	nil	nil	nil
e	—15.6	—62.5	—141	—250
f	+20	+36	+25	+26
g	—25	—25	—25	—25
Total	+42.2	—48.3	—121.2	—257.4

Grand Total.

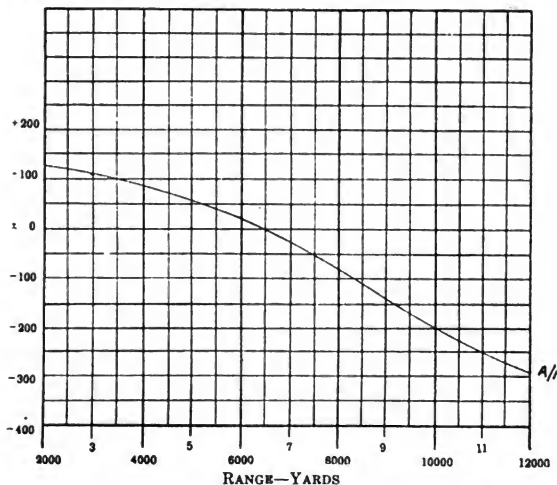
Range	3000	6000	9000	12000
A/1 I	+72	+108	+144	+180
II	—9.3	—36	—130	—205
III	+42.2	—48.3	—121.2	—257.4
Total	+104.9	+24.7	—235.2	—282.4
I				
II				
III				
Total				
I				
II				
III				
Total				

Totals I., II., and III. are now added together and their sums plotted on the squared side of B.C.'s correction form.

If firing is not likely to take place for some time only I. and II. would be totalled up and a curve drawn for these two only, leaving III. till the target was actually pointed out, when corrections under this head could be added to that shown by the curve.

Figures in heavy type are only printed in as examples, and in the natural course of events would be entered by the B.C. in pencil.

The blank space left can either be utilized for rough work or else for the B.C.'s initial deflection.



BATTERY COMMANDER'S INITIAL CORRECTION FORM

WIND SCALE

The attached Wind Scale is of convenient size for the breast pocket, and is made out for the 9.2" Mk. X., full and $\frac{1}{2}$ charges, and the 6" Mk. VII., full and $\frac{1}{2}$ charges.

Each quadrant of the circle gives a factor for three directions of wind, *i.e.*, up or down range, 30° and 60°, the 30° factors are applicable to a I., V., VII., or XI. o'clock wind, and the 60° factors to a II., IV., VIII., or X. o'clock wind.

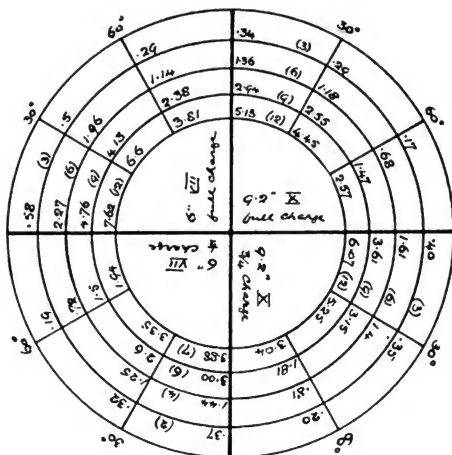
The four inner circles represent four different ranges which are shown by the numbers in brackets, thus (3) = 3000 yards, etc.

The scale is made out in a similar form to that used in rifle shooting, and is based on Major Dykes' wind formula.

The factors shown are the values of this formula taking the wind

velocity as 1 f.s. up or down range at four ranges, and multiplied by cosine 30° and cosine 60° to give factors which can be utilized if the direction of the wind makes an angle of 30° or 60° with the line of fire.

WIND SCALE



Rule $f_s \times \text{Factor} = \text{yards correction}$



The flags showing velocity of winds are taken out of the ordinary rifle shooting score book, and are the most practical method of estimating the force of the wind.

—*Journal of the Royal Artillery*, November, 1909.



A UNIVERSAL SHELL

The Rhine Machine and Metallic Works have at last solved the problem of a universal type of projectile for guns in the shape of a *high explosive shrapnel*; this type can act as a grenade, splintering after percussion, and as a shrapnel, bursting in the air. This type is highly needed, because, in using two types of shells, the artillery is obliged to drag about in its caissons and limber-boxes a mixed supply of both, having no normal indication as to the obligatory number of the one and the other, but taking them in a proportion dictated by

chance considerations, which often may prove to be just the reverse of the requirements of the respective battle action.

The universal shell is built on the principle of giving to the modern shrapnel a strong explosive action, to make the ranging easy and the correction of sighting also, by means of watching the burstings.

Therefore the inventor shaped the lower part of his shell for the shrapnel like action, and this part does not much differ from the modern shrapnel; only instead of the sulphur, which protects our bullets from untimely bursting and increases the cloud of smoke after the explosion, the inventor put there a certain composition, which, at the shrapnel action, forms the smoke, but a percussion action gives an extra supply of explosive material.

The upper part of the projectile contains the fuse with the charge, the smoke giving stuff and the tube with detonator of double action.

When set for a stroke (percussion), the upper part of the charge only will explode and act as a grenade, giving a great number of splinters, the detonation communicates to the shrapnel part, which also explodes in splinters hitting quite sufficiently, and gives a well perceivable cloud of smoke.

When set for a shrapnel action the fire will reach the bottom part with the charge and cause the explosion and the dispersion of bullets forwards; simultaneously the grenade part tears away and continues the flight (which is very important) in the continued direction of the trajectory of the shell, bursting at the fall like a high explosive grenade and giving a cloud of smoke.

The destructive action of this projectile is very strong, quite sufficient for such objects as are usual in war time, houses, brickwalls, timber-barriers, enemy's guns, light earthen protections, etc. Inflammable materials like hay, wooden buildings, corn stores, catch fire rapidly enough. Live men, detachments, etc., suffer not less, physically, as well as morally.

The detonation of this shell is calculated so, that the explosion follows immediately the stroke (blow), viz: when the shell had not yet time to dig itself very profoundly in the earth, or make a big ricochet; the result being that bullets and splinters flow ahead and their dispersion embraces a greater surface of hitting than the filling of the presently used shrapnel. Big splinters proved to have enough live force for piercing steel shields of guns from a distance of 20 to 30 meters.

The shrapnel action of the new shell exceeds that of the existing shrapnel. The grenade part, if hitting the protecting shield, disables the whole staff of a gun.

The observation of the fall of shells is much easier, the expenditure of stray shells at not right sighting, is less. Sighting is easier. Regulating the fire also.

Thus the average point of bursting gives astonishing results and certainly this new shell will have a brilliant success. The invention is property of a private factory, which is now expecting large orders.



ILLUMINATING SHELLS FOR COAST DEFENSE

Experiments were recently carried out at Toulon with illuminating shells, or bombs, fired from coast mortars, for the purpose of illuminating a target and for searching areas, too distant to be covered by shore searchlights. These were supplementary to experiments at Toulon held in May, 1909.

Four 95 mm. (3.7-inch) R.F. guns in the lower battery on Cape Brun were

employed for firing these shells, and the 155 mm. (6-inch) guns in Fort Cape Brun were used for firing at the target. The 95 mm. guns were about 40 feet above sea level and the 155 mm. (6-inch) guns are nearly directly above them at a height of about 370 feet above sea level. The old coast defense vessel *Terrible* which was used as a target was anchored about 5000 yards distant from the battery.

The object of the experiment was to determine the best way to illuminate a hostile vessel at night, when the latter was outside the effective radius of a shore searchlight.

The pyrotechnic bomb used was one of the two kinds that we have experimented with, viz: That giving out a shower of stars and adjusted to burst in the air at a required distance, the slowly falling stars illuminating a considerable area beneath them. These stars remain alight for about 50 seconds, and the bombs were fired at intervals of about 30 seconds.

It is stated on good authority that about 50 rounds were fired at the *Terrible* from the 155 mm. (6-inch) guns and that very good shooting was done, the target being brightly illuminated so that the sights could be adjusted by observing the fall of the shots. It is thought that these bombs could be used effectively at a distance of 8000 yards, and possibly more.



COMBUSTION OF COAL

By LEWIS SANDERS, M. E., General Engineering Company, New York

Logically the first point to consider in the economical generation of steam is the proper purchasing of coal, but it is not in most cases the one that is desirable to consider first. In most plants the local market governs the kind of coal bought, and coal is generally bought under contracts with time still to run. It is therefore of greater interest to learn how to burn economically the coal that we have than to learn how to buy a better coal.

To learn to burn coal economically we must first understand the process of combustion and see in what manner we can ascertain whether the coal is being burnt properly or not.

Coals vary greatly in composition and in behavior during combustion. The principal combustible element in coal is, of course, carbon, then hydrogen, and some sulphur. The remaining constituents are nitrogen, oxygen and the ash, consisting of various mineral impurities.

The requisites for proper combustion are that the fuel shall be raised to the temperature of ignition, that there shall be sufficient oxygen for complete combustion, and sufficient time for it to take place before the gases of combustion are cooled.

Part of the above conditions is governed by furnace construction, but the question of oxygen supply is entirely one of operation; we will discuss that first.

When one pound of pure carbon is completely burned it forms CO₂ and produces 14,650 BTU. If incompletely burned it forms CO and produces only 4,450 BTU, a loss of 10,200 BTU from that given by complete combustion. The process of combustion, as carried out under a steam boiler, is extremely rapid, a matter of seconds only. If just the theoretical quantity of air were furnished, combustion would not be complete, because all particles of carbon would not have had time to come in contact with the oxygen required for their combustion.

That this is so will be seen if we consider a group of 50 carbon atoms; these require for complete combustion 100 oxygen atoms. Suppose 100 oxygen atoms came in contact with these carbon atoms and combined with them so that those on the outer edges of the group had their full quota of oxygen while a few in the center did not. It would make no difference that there were sufficient oxygen atoms on the outer edge of the group to combine with the carbon atoms in the center, because there would not be sufficient time for them to get together.

It is evident then that we must have a surplus of air. Practice has shown that with properly constructed furnaces and baffling, 40% excess air is sufficient to insure a full supply of oxygen atoms at all points and permit complete combustion.

Finding that we require 40% excess air, the next question is as to the limit in the other direction. If we have too little air we lose by incomplete combustion; if we have too much, what loss do we incur?

The generation of steam in a boiler is accomplished by passing hot gases through it, the heat being absorbed by the water on account of its lower temperature. The gases, therefore, cannot leave the boiler at a lower temperature than the steam, and in fact not so low, as the rate of absorption of heat becomes very slow as the temperatures approach each other. We may take as average cases, with the best boilers, that the gases leave the boiler at a temperature of 500 degrees F. and if economizers are used the gases leaving them will be at a temperature of 350 degrees F.

The average temperature of the air entering the furnace is about 60 degrees F. We then are losing heat up the chimney to an extent represented by raising the gases of combustion from 60 F. to 500 F., or an increase of 440 degrees F., or if economizers are used, the difference in temperature between the incoming and exit gases is 290 degrees F.

The specific heat of air being 0.2375, the heat units lost up the stack per pound of air are 104 BTU, or with economizers 69 BTU. The theoretical amount of air required for the complete combustion of one pound of coal is about 12 pounds. We have seen that in practice we need 40% in excess of this, or 16.7 lbs., making 17.7 lbs. flue gas. This means a minimum loss up the stack of 1840 BTU without, and 1221 BTU with economizers. If instead of using only 40% excess air we had 100% excess, we would use 24 lbs. air per lb. of coal, resulting in 25 lbs. of flue gas. The losses in this case would be 2600 BTU and 1725 BTU respectively. The losses in each case in excess of the previous one are 760 BTU and 504 BTU per pound of coal.

We see then that using too much air for combustion entails increased loss of heat up the stack, and that this loss may be reduced by keeping down the air supply as near as possible to the 40% excess, over theoretical, that practice has shown to be necessary. In the case considered, the unnecessary loss occasioned by using so much air amounted to 5.2% of the total heat of the coal burned, when no economizers are used, and to 3.4% when they are. These figures do not take into account the heat carried off by the latent heat of such water vapor as is in the flue gases; this will increase the loss.

Having determined that to get the best results from burning our coal we should have combustion take place with 40% excess air present, or about 17 lbs. per lb. of coal, the next point is how we are to know when we have these conditions.

It is obviously impracticable to have the grates under the boiler mounted on scales and to meter the air entering the furnace in order to determine the

proportions of coal and air. If we turn to the flue gases, however, we have a very simple way of ascertaining what we wish to know, as by chemical analysis we can determine the quantity of air employed in burning the coal. Within the limits of interest to the engineer, the air is of constant composition, consisting of 20.7% oxygen and 79.3% nitrogen by volume, or 23% oxygen and 77% nitrogen by weight. There is also present in the air some CO_2 and some rare gases, but all in such minute percentages as to be of no interest to the operating engineer. The following table gives the principal data regarding the elements in the coal and air entering into the process of combustion. From it we can determine the composition of the flue gases and the heat balance of the boiler. S—sulphur, H—hydrogen, C—carbon, O—oxygen, N—nitrogen.

Table I.

Substance.	Products of Combustion.	Wt. of O required for Complete Combustion of 1 lb. Pounds	Wt. of Product of Combustion. Pounds	Specific Heat.	Volume of 1 lb. of Gases Cu. Ft.
S	SO_2	1	2	.154	5.88
H	H_2O	8	9	.60	—
C	CO_2	2.66	3.66	.217	8.16
O	—	—	—	.217	11.20
N	—	—	—	.244	12.76

1 lb. of O from air carries with it 3.32 lbs. N.

First consider the combustion of pure carbon with 40% excess oxygen. From Table I, one pound of carbon requires 2.66 lbs. O and produces 3.66 lbs. CO_2 .

	C	+	O	+	N	=	CO_2	+	O	+	N
Lbs.	1	3.72	12.36	=	3.66	1.06	12.36				
Cu. Ft.				=	29.80	11.88	1.58				
% by Vol.				=	15%	6%	79%				

That is, pure carbon burned with sufficient air to supply 40% excess oxygen would have 15% CO_2 present in the flue gases.

A typical Pocahontas coal has the analysis S, 0.57%; H, 4.58%; C, 85.9%; N, 1.07%; O, 3.24%; ash 4.6%.

From Table I we can tabulate the results of burning 1 lb. of this coal with 40% excess air, considering that 2% of the carbon will remain unburnt in the ash.

Example of calculation: We have in one pound of the coal 0.859 lbs. carbon of which 2% will probably remain unburnt in the ash. Referring to Table I, one pound carbon requires 2.66 lbs. O for complete combustion, then 0.895 lbs. with 2% unburnt require $0.859 \times 0.98 \times 2.66 = 2.248$ lbs. O. Weight of products of combustion (CO_2) $0.859 \times 0.98 \times 3.66 = 3.085$ lbs. Volume of products of combustion; from Table I, one pound CO_2 occupies 8.16 cubic feet; we have $3.085 \times 8.16 = 25.2$ cubic feet; which is 13% of the total permanent flue gas produced in burning one pound of this coal with 40% excess oxygen.

Having determined the amount of oxygen required for burning each constituent of the coal, add 40% to the total and deduct from this the amount of O in the coal; the balance of the O must be supplied from the air. Each pound of O supplied from the air carries with it 3.32 lbs. N. which is added that already in the coal; it plays no part in the combustion and merely dilutes the flue gases.

Table II (40% Excess Air).

	Wt. Lbs.	Weight O Required.	Wt. Products Combustion.	Cubic Feet.	Per Cent. By Vol.
S	0.0057	0.0057	0.0104	0.583	0.3
H	0.0458	0.3664	0.4122	Condenses	Condenses
C	0.859 x 98%	2.242	3.085	25.2	13.0
N	0.0107	—	12.211*	156.0	81.0
O	0.0324	—	1.06*	11.8	6.1
Ash	0.046	—	—	—	—
Total O		2.663	16.778	193.6	

* Includes O and N added from the air used in combustion.

Total O + 40%	3.72
Less O in Coal	.03
Required from Air	3.69
N from Air	12.2

Pocahontas coal burned with 40% excess air, then, produces a flue gas containing 13% CO₂ while pure carbon gave 15% CO₂. The difference is due to the hydrogen in the Pocahontas coal; this burns to H₂O which condenses, but leaves in the flue gas the N that accompanied the O from the air that supported this part of the combustion.

If the coal were burnt with 100% excess air instead of 40%, the only constituents of the flue gas that would be altered are the O and N, as clearly no further alterations can take place in the S, H, and C they being completely burned in the first case. From Table II, total O required for combustion is 2.663 lbs. plus 100% = 5.326 lbs. less 0.03 lbs. in the coal = 5.296 lbs. from the air, carrying with it 17.6 lbs. N; we can then form Table III.

Table III (100% Excess Air).

Gas	Weight	Cubic Feet	Per Ct. by Vol.
SO ₂	0.0104	0.583	—
H ₂ O	0.4122	—	—
CO ₂	3.085	25.2	9.0
N	17.6	224.5	80.2
O	2.663	29.8	10.6
	23.7	280.083	99.8

Table IV (For 200% Excess Air).

Gas	Weight	Volume Cubic Ft.	Per Ct. Vol.
SO ₂	0.0104	0.583	0.14
H ₂ O	0.4122	—	—
CO ₂	3.085	25.2	6.0
N	26.40	337.0	80.0
O	5.326	59.5	14.1
	35.2	422.2	100.2

On examining Tables II, III, and IV we find that the volume of SO₂ is so small as to be negligible and that the H₂O condenses. The same volume of

CO_2 is present in each case but it forms a less percentage of the total gas. The N increases in quantity but its percentage relation does not alter much. The O increases in volume and in percentage.

If we know the percentage of either CO_2 or of O in the flue gas it is evident, from these tables, that we can tell how much surplus air was used in combustion.

The percentage of CO_2 is the most convenient to use on account of the ease with which it can be determined. It is only necessary to take a sample of the gas and measure its volume at atmospheric pressure, a very simple matter. It is then brought in contact with a strong solution of caustic potash (KOH) which rapidly absorbs the CO_2 . The sample is again measured and the loss in volume represents the CO_2 which has been absorbed.

The apparatus generally used for ascertaining the amount of CO_2 in the flue gases, is the Orsat. This apparatus is also used to determine the amount of CO , and of O.

The Orsat apparatus consists of a burette or measuring vessel and the absorption vessels.

Referring to the illustration, 1 is the burette consisting of a glass tube with graduations for every 0.2 C. C. up to 50 C. C. and every 0.5 C. C. from 50 C. C. to 100 C. C. This is usually enclosed in a water jacket 2 to prevent change of temperature while the gas is being measured. The bottom of the burette is connected with a long rubber tube "3" to a bottom outlet in the bottle "4."

In making an analysis of the flue gas, the tube "16" is connected to a piece of iron pipe projecting into the flue. The three way cock "14" is opened so that the glass tube "7" is connected to the atmosphere through the hollow end of the flue cock, "15." The cock "6" is opened and the cocks "8," "12," and "13" closed. The solutions must be at the marks "17," "18," "19." The bottle "4," which is full of water or better, salt and water, is then raised until the water rises in the burette, completely filling it to the mark "5" on the glass stem. This expels all the air through the cock "14," which is now turned so as to connect "16" with "7," the bottle "4" is then lowered and the water runs back into the bottle drawing flue gas through "16" into the burette.

The gas drawn from the boiler passes through the "U" tube, "22" which is connected in the tube "16." The two legs of the "U" tube are loosely filled with cotton waste and 2 or 3 C. C. of water placed in the bottom of the "U" tube. The function of this tube is to filter the gas and also to saturate it with moisture so as to eliminate any error due to vapor tension.

The cock "14" is again turned so as to open "7" to the atmosphere and the bottle "4" again raised expelling the gas to the atmosphere. This operation should be repeated half a dozen times to insure that a fresh sample of gas has been obtained.

Having a fresh sample of gas in the burette the cock "14" is again opened to the atmosphere and the bottle "4" very slowly raised. When the liquid reaches the 100 C. C. mark in the burette the cock "14" is closed. There is now a 100 C. C. sample of the gas in the apparatus ready for analysis. Open cock "8" and continue to raise bottle "4" until the liquid rises to mark "5."

The gas has now been forced into the glass vessel "9" which is filled with a strong solution of caustic potash; vessel "9" generally contains a large number of glass tubes, so as to present as large a wetted surface to the gas as possible. The bottle "4" is raised and lowered several times causing the gas to pass

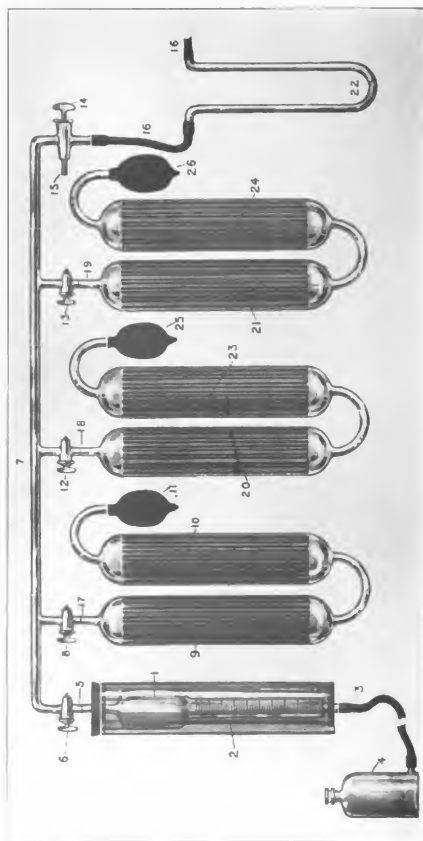
backward and forward several times between the absorption vessel "9" and the burette "1." The vessel "10" is to receive the caustic potash solution displaced from "9" when the gas is forced over.

The upper openings of vessels "10," "23," and "24" are connected to the rubber bags in "11," "25" and "26." These receive the air displaced by the solution when driven into these vessels by the passage of the gas into the absorption vessels. The object of this is to keep the atmospheric air from contact with the solution.

The bottle "4" is now lowered until the caustic potash solution in "9" rises to the mark "17" when the cock "8" is closed and also the cock "6," the entire sample is now back in the burette "1." The bottle "4" is now raised very slowly, keeping it as close as possible to the burette "1" until the liquid in "4" stands level with that in "1." The gas in the burette is then at the same pressure as the atmosphere and the level of the liquid in "1" should be read. The original sample was 100 C. C. We will suppose that the liquid in "1" now stands at the 89 C. C. mark, this shows that 11 C. C. of the original sample has been absorbed by the caustic potash in vessel "9." The gas that was absorbed is CO_2 ; there was, therefore, 11% CO_2 in the flue gas. The cocks "6" and "12" are now opened and the bottle "4" raised, transferring the gas to vessel "20." This vessel contains a solution of 18 grams of pyrogalllic acid in 40 C. C. hot water, to which is added 70 C. C. of caustic potash solution, of a specific gravity of 1.26. The gas must be passed backward and forward between the burette "1" and the vessel "20" several times until no further absorption is noticed. The solution in "20" is then brought back to its mark, "18" and the cock "6" closed and the volume of gas in "1" measured as in the preceding case. We will suppose that the new reading is 81 C. C., this indicates that 8 C. C. of gas have been absorbed by the solution in "20." The gas absorbed by this solution is oxygen and there is, therefore, 8% of oxygen in the flue gas. The cocks "6" and "13" are now opened and the gas passed over into the vessel "21"; this vessel contains a solution of cuprous chloride consisting of thirty-five grams of cuprous chloride dissolved in 200 C. C. of strong hydrochloric acid to which fifty grams of copper clippings are added and the mixture allowed to stand in a glass-stoppered bottle for twenty-four hours before using. 100 C. C. of water is added to the solution before using; no precipitate should form on adding the water. Each of the loose glass tubes contained in vessel "21" should have a spiral of fine copper wire in it. After passing the gas into vessel "21" several times, the solution is restored to the mark "19" and the cock "8" is then opened and the gas passed several times into the vessel "9." This is necessary because the gas has taken up the fumes of hydrochloric acid in vessel "21" and it is necessary to absorb these by the solution of caustic potash in "9" before making the final measurement. The solution in "9" is now restored to the mark "17" and the cocks "8" and "6" closed and the volume of gas in "1" measured as before. We will suppose the new reading to be 80.9 C. C. then .1 of C. C. of gas have been absorbed in "21." The gas absorbed in "21" is carbon monoxide and there was, therefore, 0.1% of carbon monoxide in the gas, the remaining gas in the burette is nitrogen.

In making an analysis of flue gas, there are several points to be observed if accurate results are to be obtained.

First: have your apparatus perfectly clean, particularly the burette, so that the graduations may be clearly read.



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THE ORSAT APPARATUS

Second: see that all the glass cocks have their openings clear and coat them with vaseline or glycerine. This is done to insure their being air tight, and to prevent their sticking, which latter is particularly apt to occur with the caustic potash cock, if not kept well coated. There is great danger of breaking the instrument in loosening it.

Third: see that the chemical solutions are properly prepared.

Fourth: enough gas should be drawn through the apparatus to saturate the water in the bottle "4" in the burette with carbon dioxide, as fresh water will absorb a certain amount of this gas and thus destroy the accuracy of all analyses made before it is saturated. The addition of salt to this water decreases the solubility of carbon dioxide in it.

Fifth: enough gas must be drawn through the apparatus to insure that all the dead gas is removed from the pipe connecting it with the boiler, and that a fresh sample is secured.

Sixth: in reading the volume of gas in the burette "1" the readings should be taken from the same part of the meniscus; that is, the saucer-shaped surface of the column of water. It will be noticed that the top of the column of water has the appearance of a saucer-shaped disc about $\frac{1}{16}$ to $\frac{1}{8}$ of an inch thick. All readings should be made from the same point on this disc, preferably its bottom surface.

Seventh: in order to secure an average sample of the flue gas, it is necessary to run a pipe about half-inch in diameter, about two-thirds way across the last pass of the boiler. This pipe should be closed at the end and should have $\frac{1}{8}$ -inch holes drilled along its length about every six inches. Unless absolutely unavoidable, the sample should not be taken from the flue, as there is great probability of air leaks between the boiler setting and the breeching connection. This would give erroneous information as to the firing, as air leaking in at this point does not affect the efficiency of the boiler, although it does affect the efficiency of economizers.

Instead of drawing the sample of gas direct to the apparatus, a sample is sometimes drawn into a two or five gallon bottle for a period of one-half hour, the gas being sucked over by first filling the bottle with water and inverting it. A long tube passing from the cork almost to the bottom of the bottle admits the gas, while the water escapes drop by drop from a short tube with a pinch cock on a soft rubber to regulate the flow. There may thus be obtained a sample that approximates the average of the gases passing through the boiler during the half-hour.

One of the first points to be determined in investigating a boiler, is the tightness of the settings, as regards air infiltrations, as air leakages cause very serious losses in the efficiency of the boiler and until they are remedied, prevent any intelligent use of the flue gas analysis in connection with furnace conditions. To determine the existence of leaks in the boiler settings, a pipe should be inserted just beyond the bridgewall as well as in the third pass, and samples should be collected simultaneously in five gallon bottles from each point for a period of one-half hour, and should then be analysed for CO_2 , and, if desired, for oxygen. It is only necessary to analyze for one constituent, although it is more satisfactory to determine both.

If the sample taken from the third pass of the boiler shows a decrease in CO_2 , or an increase in O over the sample taken at the bridge wall, there is indication of air leaks in the setting which should be looked after and closed.

—*Sarco: A Bulletin of Power Plant Practice*, May and October, 1909.

(To be continued.)

TELEGRAPHIC TRANSMISSION OF PICTURES

The photo-telegraphic systems now in commercial use are all based on the researches of Bakewell, who attempted experimentally the solution of the problem of transmitting pictures electrically as early as 1847, and of the later investigators, Caselli, d'Ardres, Didwell, Eaton, Amstutz, and Kiszelka. The establishment of the commercial utility of photo-telegraphy, however, did not occur until 1908, when the Korn system was installed between the offices of the *Lokal Anzeiger* in Berlin, *Illustration* in Paris, and the *Daily Mirror* in London. Some interesting details of the leading systems now in use, particularly that of Professor Korn, whose selenium process was the first to reach a practical stage, are given in a paper by T. Thorne Baker, read before the Royal Society of Arts and published in the *Journal* for November 26, 1909.

Professor Korn's process is based on the discovery of Shelford Bidwell that the electrical resistance of the metal selenium, when in a certain physical state, increases inversely with the amount of light which falls upon it. An enlargement of the photograph to be transmitted is printed on a sheet of transparent celluloid, which is wrapped around a revolving hollow glass cylinder. The rays of a Nernst lamp are focussed upon the photograph by means of a lens, and after passing through the film and cylinder are deflected by a prism fixed inside the cylinder on to a selenium cell. The cylinder, as it revolves, rises spirally, and the density of each successive portion of the photograph, as it passes the point of convergence of the rays of light, varies the intensity of the light which traverses it. Hence the light falling upon the selenium cell varies in exact accordance with the density of the portion of the photograph traversed by the rays at any instant, and an electric current passing through the selenium, whose resistances changes when illuminated, varies each instant also in accordance with the tones of the photograph.

The changes in resistance of the selenium, however, do not respond quickly enough to the changes in density of the photograph. To overcome this defect, Professor Korn causes two selenium cells, one of high, and other of low, inertia, their resistance being low and high respectively, to be illuminated simultaneously; the lag in one cell counteracts that in the other. These cells are connected in series, and the two are connected bridge fashion with the receiving galvanometer. The lag in the physical action is greatly overcome because the current depends on the sum of the effects of the cells on each side of the bridge, and when illumination ceases the current falls to zero.

The receiving galvanometer consists of a large electro-magnet with a hole bored through the poles. Opposite the centre of the hole, a small magnesium shutter is attached to two fine silver wires 0.001 inch thick stretched between the poles. The current passes through these wires (which are in parallel) and a lateral displacement takes place, there being practically no torque, so that the shutter moves aside and rays from a second light can pass through to a sensitive photographic film on a second revolving cylinder. In transmitting, a prism is placed in the path of the rays, which deflects them downward on to the compensating selenium cell. It is in this way that the compensating cell is illuminated, as the moment light falls on the principal cell, current passes through the galvanometer and light is allowed to fall also on the second selenium cell. In receiving, however, the prism is removed and the light falls upon the sensitive film. The shutter moves aside more or less according to the current received from the transmitting station. Hence the light concentrated optically upon the revolving film is more or less intense according to the light

and shade in the photograph being transmitted. The development of the film produces a photograph similar to that used at the sending station.

The transmission troubles in working with a line voltage of about 200 volts in a circuit where the maximum current received is about one milliamperere are sometimes very great. A closed circuit is necessary and hence telephone lines are employed. The first pictures were transmitted by Professor Korn from Berlin to Paris in October, 1907, and from Paris to London in November of the same year.

Later Professor Korn devised a telautograph, by adapting a Caselli transmitter to a modification of his own galvanometer, by means of which line drawings can be transmitted with remarkably good results. The picture is drawn in gum or shellac lines on a copper sheet which is attached to a metal drum revolving spirally at the rate of 330 revolutions per minute under a steel tracer or style. The metal drum is connected to one end of a battery (about 60 volts), the other end of which is connected to one of the telephone lines; the other telephone line is connected to the style. The interruptions of the current caused by the passing of the gum lines beneath the style are utilized to build up a photographic image in the receiver. The receiver consists of a revolving drum to which a sensitive film or piece of paper is attached. The light from a Nernst lamp traverses a hole bored through the poles of the electro-magnet and falls on a fine slit; over this slit falls the shadow of a fine flat wire which is stretched across the optic path and is free to rise and fall between the poles. When the wire is in the normal position, the slit is covered with its shadow. When current flows in the line, it flows through the wire, which is thereupon displaced, the shadow is thrown off the slit, and light passes through it and is concentrated on the sensitive film. At each line in the sketch being transmitted, therefore, the current is interrupted, the shadow falls upon the slit, and the film remains unexposed. When the film is developed, a negative photographic image of the sketch is produced. A positive image may be received direct on bromide paper.

Photographs split up into lines by means of a single-line half-tone screen can be transmitted by the Korn telautograph and many experiments are now being made to improve their quality. One of the drawbacks so far has been that the half-tone screen contains a definite number of lines to the inch, and that therefore a regular train of impulses is sent into the fine wire in the receiving galvanometer, which tends to swing with a definite frequency, and so not to correspond exactly with the width of the lines, upon which the tones or shades in the photograph entirely depend. The results so far obtained, however, are very promising.

Quite recently some very successful results have been obtained by M. Belin, of Paris, whose transmitter is based on that of Amstutz. In the Belin system, a gelatine relief photograph, such as is prepared by printing from a negative upon paper coated with a sensitive mixture of gelatine and a bichromate, is attached to a cylinder and revolved spirally. A metal style, attached to the membrane of a microphone, presses against this cylinder. As the photograph revolves, different thicknesses of the gelatine press against the style, owing to the varying relief, and the membrane is pressed more or less inwards. This varies the magnetic field as speaking does in the ordinary telephone, and the varying current is sent to the receiving station.

"The receiver consists of a light, a galvanometer, and a drum, to which a sensitive photographic film is attached. The galvanometer is a Blondel oscillograph, in which two fine phosphor-bronze wires pass between the poles

of an electro-magnet, a small mirror being attached to them in the central part of the magnetic field. This mirror is so arranged that it reflects light from a Nernst lamp on to a diaphragm with a rectangular aperture over which is placed a piece of glass varying from practically complete to small transparency, so that the more the mirror is deflected the more the beam inclines to the very transparent side of the graduated glass. What light does pass through is concentrated by a lens as a small spot on the sensitive film, and in this manner a photograph is obtained, the movements of the mirror corresponding to the pressure on the microphone."

In Mr. Baker's own system a Caselli transmitter is employed, as in the telautograph, but the half-tone photographs are printed in fish glue upon lead foil, and the lines are pressed into the soft metal, so that there is no friction at the style. This tends to give better synchronism and prevents vibration of the style. The receiver is very simple, and is, in appearance, the facsimile of the transmitter. A piece of chemically prepared paper is wrapped around a metal cylinder and the current received is passed through the style into the cylinder through the paper. Every time the current flows, a chemical mark appears on the paper by electrolytic action. The paper is sufficiently sensitive to record five or six hundred dots a second, while the receiver is fitted with a simple regulating device by means of which the distortion of the currents caused by their passage through a long-distance line can be completely overcome.

Mr. Baker believes that by means of his selective selenium apparatus Professor Korn is likely to find a practical solution of the problem of transmitting pictures over distances as great as from London to New York. Mr. Baker himself is attempting to solve the same problem by means of wireless, and in conclusion he describes some of his experiments and the wireless arrangement which so far has given most promise of success.

—*The Engineering Magazine*, January, 1910.



FIRINGS AGAINST THE JENA

The firing against the battleship was ended November 30, 1909, with the capsizing of the ship. The most previous lessons gained from the experiments bear upon the use of armor-piercing shell versus the torpedo-shell bursting outside. All the results seem to favor the former, and those who blamed the French Ordnance Department for its haste in supplying ships of the *Danton* class solely with A.P. shell will have to confess to defeat.

The battle of Tsu-shima seems the only modern fight furnishing any lessons on this subject. The whole international naval press has been filled with reports of the wonderful effects of the Japanese shell, the famous "valises" or "portmanteaux". We may admit their effect, but we must also remember the state of overloading of the Russian ships. These shell did not have good ballistic qualities; many were too long; we know that many tumbled. The same results were recorded in the *Jena* experiments against our own shell, containing 10% of explosive.

Now, are conditions, in what concerns the work projectiles must do, the same in 1910 as in 1904? We think not, since *Dreadnoughts* are the outcome of the Tsu-Shima lessons. If armament has been perfected, so have the means of defense, and now the armored part covers about three-fifths of the ship's

side surface. Large capacity shell are not the thing to attack the thickest Harveyized walls with, for such shell as compared with such armor are like porcelain.

The principle of perforation again resumes all its ancient value; it furnishes the sole means of effective action against both personnel and material.

Unity of projectile is as important as unity of caliber; at long ranges density of fire is possible only with big guns. Every shot from a heavy gun must tell at any of its effective ranges. Our new 12-inch shell "*obus alourdi*" has realized this desideratum, largely thanks to its special fuze.

Nevertheless, we must not be surprised if this heavy shell suffers in some respects in comparison with the older type—the semi-rupture. Under equal perforation, the old shell may do more damage, but it may not perforate as well. The particularly destructive effects of the old semi-rupture shell behind armor it had perforated, its good fragmentation and incendiary qualities, seem to bear an intimate relation to the weight of explosive it carried, viz: 46 lbs. The relation between weight of explosive and total weight in this shell would seem then a good one to approximately maintain in the new heavy shell. This would doubtless give the same explosive results combined with the new shell's greater perforation. (Note. The regulation semi-rupture shell weighs 750 lbs., the melinite in it, 46 lbs; in other words, it carries about 6% of its weight in explosive.)

It seems rational, in designing a shell, to base our calculations upon the quantity of explosive we can carry through. Length of projectile, after a certain point is reached, has most serious disadvantages, and this perhaps will explain why the English persist in retaining an 847 lb. projectile among other 12-inch shell; ballistic considerations and the sanction of experiment decided them.

And yet, to penetrate, we must have increased striking energy. To gain this by a further increase in present velocities seems imprudent. The weight of the projectile must, therefore, be added to. This can be done only by lengthening the projectile (but not beyond the limit of perfect stability) and by increasing the caliber.

The English are working on a 13.5-inch gun comparable to the American 14-inch gun. If the French navy returns to the 340 mm. (13.4-inch), it would be adopting a caliber corresponding to future fighting ranges and to that weight of explosive which will produce the maximum effect after perforation.

The fuze which is spoken of above, used successfully in the firings, is the Watson fuze, commonly called the W fuze. The only thing which can be learned about this fuze is that it is the English Watson fuze considerably modified by the French. The English Admiralty is known to have tried this fuze, but while thinking it fairly good, they did not find it at all perfect. The French must have considerably improved it.—*Moniteur de la Flotte*, February 5, 1910.



METALLIC FOULING IN SMALL ARMS BARRELS

Since the adoption of the modern rifle with the steel jacketed projectile it has not been necessary, according to the opinions expressed by army officers, to pay any attention to metallic fouling. It is maintained that this is more particularly true since the Government began the manufacture of smokeless powder.

Lieutenant Col. Velloso Pederneiras, Director of the Government Smokeless Powder Factory at Piquette, Sao Paulo, maintains that the *graphite* used in the smokeless powder composition acts as a lubricant, thus doing away with metallic fouling entirely.

Lieut. Col. Pederneiras further maintains that the formula used by the Government in the manufacture of smokeless powder is the same as that used by the United States.

The above is all the information at present obtainable on this subject.



FOR SMALLER BATTLESHIPS

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There are reports that with the arrival of Admiral Wilson at the Admiralty as First Sea Lord, in succession to Lord Fisher, there will be some startling changes in Great Britain's naval policy. The most important of these, it is said, will be the partial abandonment of the *Dreadnought* design for battleships.

Admiral Wilson is not altogether enamored of the *Dreadnought* type and is said to have convinced himself that the present need of the navy is not so much battleships as armored cruisers. It has been understood that if he went to the Admiralty there would be a possibility of a reduction in the displacement of future British warships, which would in turn lead to the necessity for building more ships to reach a given strength.

There is a general impression that there would be a drop of something approaching 7,000 tons in battleship displacements either this year or next, the new vessels being of 13,000 or 14,000 tons and of the Lord Nelson type. An armament of two 13.5-inch and twelve 9.2-inch guns is suggested, large reductions being made on the armor protection given to the Lord Nelson and modifications in the general shape of the ship.

Discussing the possibility of this "very startling departure," H. W. Wilson, a well-known writer on naval matters, says:

"Since the original *Dreadnought* was launched, in 1905, eighty-five battleships and armored cruisers have been laid down or projected for the various navies. Every single one of them is of the *Dreadnought* or monster battleship type. Every single navy has adopted that type—the United States, Japanese, German, French, Italian, Austrian, Brazilian, and Argentine. This absolute consensus of naval opinion in favor of the type is the strongest argument that the *Dreadnought* is the right design in general outline.

"The reason why the world is building monster battleships can be understood by comparing the fighting qualities of the latest type of *Dreadnought* with those of the small battleship. They are as follows stated in parallel:

	Dreadnought <i>U. S. S. Wyoming</i>	Small Battleship <i>H. M. S. Duncan</i>
Tonnage	26,000	14,000
Cost	£2,000,000	£1,000,000
Speed, knots	22	19½
Armament	{ XII. 12-inch XXII. 5-inch	IV. 12-inch XII. 6-inch
Broadside	11,110 lbs.	4,000 lbs.
Armor, side	11-inch	7 inch
Crew	1,100	750

"Owing to improvements in modern engineering it might be possible to give a new Duncan a little heavier armament and an extra half knot, but even then two Duncans would cost as much as one *Wyoming*, would need far more than the same number of men, would carry between them a far weaker battery than the *Wyoming* mounts, would be much worse protected, and would be at least two knots slower at sea.

"They would not be able to fight their guns in weather when she could use hers with deadly effect. The only advantage in building two of them in place of one *Wyoming* is that it would be harder to sink two ships with a mine or torpedo than one.

"In practically every military quality the small ship is worse than the big one. The *Wyoming* could play with the *Duncan* as a cat plays with a mouse. Against a whole squadron of *Duncans* she would be more than able, if well maneuvered, to hold her own.

"The French experiments on the hull of the *Jena* suggest that it will be impossible to protect a medium sized or small ship effectively against the fearful fire of modern artillery. With ordinary luck the *Wyoming* would be hitting twelve times a minute with her 12-inch shells, piercing the *Duncan's* armor at every shot. The *Duncan* would only hit the *Wyoming* four times a minute, and her shells would not go through the *Dreadnoughts* thicker armor. How long would a duel under such conditions last?

"These are some reasons why I find it hard to believe that the *Dreadnought* policy is to be abandoned in the British navy. We want to give our *Dreadnoughts* 6-inch guns in addition to their heavy battery, but that involves no drastic change, no complete reversal or revolution."

Meanwhile, the naval program prepared for the coming year by Lord Fisher, lately First Sea Lord of the Admiralty, makes provision for the laying down of four *Dreadnoughts*, with power, it is said to begin the construction of others probably two in number, should it become advisable. This policy of allowing some optional excess over the fixed minimum of construction is likely to become under present conditions a settled principle with the British Admiralty.

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—From the *London Times* in the *Army and Navy Register*, February 26, 1910.

Short Notes.

New French Battleships.—As is already known, the French battleships which it is intended to lay down this year are to be of 23,000 tons, and to have an armament of twelve 12-inch guns in six turrets, of which two forward superposed, or firing one over the other, two abaft arranged in the same manner, and one on either broadside. The smaller armament was to consist of 18 guns of 5.5-inch, in groups of three in casemates, of which three on either side. The plans have been prepared in anticipation of the Budget discussion, and the Minister has added four of the smaller guns, mounted two on either side of the stern, and has increased the proposed defensive qualities of the ships. There will be a waterline belt, ranging from 10.6 inches amidships to 7 inches at the extremities, and this belt will rise to a height of 7 feet 4 inches above the water, and descend to a depth of 8 feet 2 inches. Still lower, plating of the

same thickness will protect the engine and dynamo spaces. There will be two armored decks, and thick bulkheads forward and abaft the turrets, the whole of the vital parts being thus enclosed.

—*Army and Navy Gazette*, February 5, 1910.

British and German Battleships.—In the comparisons that are being made between the latest battleships of the British and German Navies, respectively, to join the first line fighting fleets, too much importance is being given to the fact that the *Nassau* class, in Germany, carry twelve 11-inch guns as a primary armament, against the ten 12-inch primary guns of our *Vanguard* class. It is true that numbers are in favor of the German ship, but it will be noticed that they are of one inch less caliber than the British guns, and their shot is therefore much lighter, while the muzzle velocity is not more. But the whole difference in fighting power is not summed up in the difference of caliber between their primary guns, but consists in the fact that although the German *Nassau* carries twelve 11-inch guns, she can only oppose eight of these as a broadside to the broadside of eight 12-inch weapons which form the broadside of the *Vanguard*. Fighting, therefore, at long range, when the admittedly more powerful secondary armament of the German ship would be of no use, the British ship would have much the best of the argument, especially as she is a couple of knots faster and so could, where there was plenty of sea room, always keep the enemy at a distance which best suited her own larger guns, and easily work the fighting position so that the sun was at the back of her own gunlayers, and in the eye of the German gunners. All these considerations arise and are favorable to the ship with the best guns and highest speed, and have to be reckoned with; whereas many critics are harping on the superior secondary armament of the German, which, in such a fight, would never come into action at all.—*United Service Gazette*, February 24, 1910.

U. S. 30,000-ton Battleship.—There is much talk in the air about the construction of a 30,000-ton battleship for the United States navy, and its cause is to be found in the advent of the new and very powerful 14-inch gun, which recently underwent successful tests at Sandy Hook. If the 14-inch gun is to be installed, and the total number of guns is to remain the same as in the *Wyoming*, an increase in displacement becomes necessary. Indeed, it is questionable whether even a 30,000-ton ship could mount twelve 14-inch guns and give them adequate protection.—*Scientific American*, March 5, 1910.

Argentine's Dreadnoughts.—The final plans of the new Argentine *Dreadnoughts* have now been passed. The ships will be called *Rivadavia* and *Moreno*. They will be of 25,000 tons displacement, and carry twelve 12-inch, twelve 6-inch, and twelve 4-inch guns. The speed will be 22 knots. There will, it is said, be two funnels and two skeleton masts of the new American type. The whole of the twelve big guns will bear on either broadside. The contract for these ships has been awarded to the Fore River Works; and in view of the fact that there was keen competition for this order among the leading shipbuilders of the world, the securing of this contract is a high tribute to American shipbuilding.—*Scientific American*, February 5, 1910.

The Heligoland Class.—A new series of details relating to the German battleships of the *Heligoland* class has been published in Germany. The displacement is given as 22,000 tons; length, 149 meters; beam, 27.87 meters;

draught, 8.39 meters; speed, 20 knots. The armament is given as twelve 12-inch fifty caliber guns, fourteen 5.9-inch and twenty 4.1-inch. The suggested displacement of 19,000 tons for these vessels, coupled with the secondary armament of twelve 6.7-inch hitherto accepted, must all along have appeared to be a very conservative estimate.—*United Service Magazine*, February, 1910.

Danish Naval Plans.—Under the new organization for the defense of Denmark the fleet is to consist of four coast-defense battleships of the *Olfert Fischer* type, twenty-four torpedo-boats or submarines, and two 500-ton mine-layers. A five-year programme has been drawn up with the object of attaining that strength at the end of that period. In the first two years the coast-defense ship *Peder Skram* will be completed, and six torpedo-boats, one mine-layer, and two submarines will be built. In the last three years a fourth ship of the *Peder Skram* type will be built, as well as four more torpedo-boats, a mine-layer and a submarine. Most of the smaller vessels will be constructed in foreign yards.—*United Service Magazine*, February, 1910.

Wilhelmshaven.—Final arrangements are now being made which will constitute Wilhelmshaven on the North Sea as Germany's chief naval port. The change should have taken place last autumn, but the houses for the officers were not ready. Wilhelmshaven will thus be the station for the First Squadron under the command of Vice-Admiral Pohl, and it will be a *Dreadnought* squadron. It will consist of the *Nassau* and *Westfalen*, which are already in commission, and the *Rheinland* and the *Posen*, which will be commissioned in the spring, although they will still have their trial trips to make. Three further vessels will be added to the squadron in the summer of 1911 and an eighth in the spring of 1912. This latter, the *Ersatz Frithjof*, will be launched from the Schichau Wharf at Danzig this year.—*United Service Gazette*, Feb. 10, 1910.

Mine-laying Steamer for Portugal.—The launch has taken place at Thornycroft's Works, Southampton, of a mine-laying steamer for the Portuguese Government. She is 110 feet in length, has a beam of 19 feet 6 inches, and a depth of 11 feet, her estimated speed being 12 knots. She is built of steel to Messrs. Thornycroft's special design for the laying of submarine mines and regulation of torpedoes. Her machinery, which will produce 400 indicated horse-power, consists of two sets of tri-compound condensing engines, with cylinders 9 inches, 13 inches, and 20½ inches diameter, having a stroke of 11 inches. The boiler is one of the firm's water-tube type, and is to work under natural draught.

The vessel is armed with one revolving 18 inch torpedo tube placed aft, and carries two sets of torpedo dropping gear at the break of the forecastle. There is a mine hold at the stern, and a pair of sheer legs worked by an electric winch for launching the mines. A steam windlass is fitted forward, and a steam air compressor in the torpedo charging room. The bunkers have sufficient capacity to permit of the boat steaming 1000 miles, at a speed of ten knots. The vessel is schooner-rigged, and is provided with a derrick on the foremast for lifting torpedoes. The decks are of teak, and awnings are fitted all fore and aft. There is accommodation aft for four officers, and forward for two officers and twelve men. The lighting throughout is by electricity, and a searchlight on a movable carriage has been provided on the bridge. There is a steam steering engine with a steam control wheel on the bridge, and a hand wheel aft. The galley and seamen's offices are situated under the bridge

in a steel house at the aft end of the forecastle, the front of the house forming an efficient breakwater. A downton pump is placed on deck for clearing the bilge and for fire purposes. In appearance the vessel is of the gunboat type. As she left the ways she was named *Vulcano* by Madame Rolla Pereira, the wife of the inspecting officer.—*The Engineer*, February 11, 1910.

Oil and Coal Fuel.—The abnormally large orders that are being placed by the Admiralty for oil fuel are a gratifying indication that the large storage tanks and reservoirs, which have been under construction at various naval bases around the coast during the last few years, are now complete and ready for use. The amount of oil fuel that can be stored at these centers and reserved for war purposes will be adequate to carry us through any naval campaign of moderate duration, and will certainly give us time to regain any temporary loss of command of the sea, before any lack of fuel for the Navy could be felt. The orders are also taken in some quarters to mean that oil fuel is to be depended upon in the Navy almost absolutely in the future, and that coal will seldom be found in the bunkers of our battleships, but there is no justification for this conclusion. The orders are rather abnormal to fill the new storage tanks only; for there are dozens of our warships not yet fitted to burn oil fuel at all, and scores of others whose furnaces are fitted to burn oil or coal; whilst of the older ships there are very few fitted to burn oil alone, outside of the vessels which have been used for experimental purposes. There is, however, one great advantage in oil fuel which has been largely overlooked, viz., the comparative ease with which vessels will be able to be restocked with fuel at sea, as compared with coaling at sea by the Metcalfe system. A large flexible hose will easily connect two ships at a safe distance in all reasonable weather, and a good pump will do the rest, so long as the vessels are kept on the same course and ordinary precautions are observed.—*United Service Gazette*, February 24, 1910.

Bomb-dropping from Airships.—It is generally thought in naval circles that the present Board of Admiralty will take up the subject of aviation with even greater zest than their predecessors, as the rapid development of the airship and aeroplane as war machines, on the Continent, make energetic action in this country a national necessity. Messrs. Vickers, Sons and Maxim are pushing along with the rigid airship, which is being built for the Navy at their Barrow works; and, as we have before stated, a party of naval men have proceeded to this center for instruction, with a view of their forming a nucleus for the foundation of the aerial department of the Fleet, which is to be set up as early as possible. Sites are likewise being selected around the coast suitable for airship garages, as it is recognized that, without being exposed to hostile gun fire, the naval airship harbors and fitting sheds must be as near the sea as possible, so that the vessels may be ready for instant service should necessity arise. As battleships ready for action are held by their iron cable leases only when riding at anchor, so must airships be ready to run out of their sheds and ascend to the "central blue" without loss of time, when their services are required to meet emergencies. The aeroplane will also find a place among naval war machines at no distant date. Lieutenant Beck, in Mr. Curtiss's bi-plane, recently experimented in dropping bombs from a height of 250 feet, at a target 15 feet by 25 feet, on behalf of the United States Army at Los Angeles; and although he was not very successful the possibility of using bombs from these vessels of the air has been proved by the experiment.

—*United Service Gazette*, February 24, 1910.

Aerostation in Japan.—The navigation of the air is attracting attention in Japan as elsewhere, and the Emperor has issued a decree establishing a board or committee of naval and military officers to investigate the questions that arise, and to take practical steps whereby the Japanese services may be provided with such airships or aeroplanes as they require. The decree is countersigned by the Minister President, the War Minister, and the Minister of Marine. The committee consists of 20 members, with president and vice-president. The former is a general officer on the active list, and the members will be staff officers of the two services, with engineers, shipbuilders, and specialists, and the committee will have officers for administrative duties attached. The members were instructed to prepare their own statutes, and to indicate the scope of their labors, and their scheme was to be approved by the Ministers of War and Marine.—*United Service Gazette*, February 26, 1910.

England's First Airship.—According to the *United Service Gazette*, the first airship for the British navy, which is now being built by Vickers, Sons and Maxim, will be the largest vessel of the kind in existence. It will be over 500 feet in length and driven by two motors of 200 horse-power each, which will be capable of driving the vessel at 45 miles an hour in still air. The nominal lifting power will be 20 tons, although its usual load, according to this authority, will not exceed five tons. It will be of the rigid type, as this is considered to be best adapted for naval purposes.—*Scientific American*, February 5, 1910.

Guns to Fight Airships (England).—I hear that extensive trials of a new gun against balloons and airships will be held on Salisbury Plain during the spring training season. The enlargement of the Balloon Factory near Aldershot has led to arrangements being made for a supply of airships, for use at the trials of the gun, and the results of experiments held last year at home and on the Continent have been acted upon in manufacturing the gun.

The inventions section of the Ordnance Branch of the War Office is beginning to experience the rush of inventors with all kinds of automatic rifles. Many foreigners are in the field, especially Belgians, but I am sure that British gunmakers will be able to hold their own and produce a weapon that will satisfy the Hythe experts and the Army Council.—*Military Mail*, February 4, 1910.

German Airships.—General von Wichhorn, commanding the IInd German Army Corps, recently inspected and made an ascent in a new military dirigible airship, *M III*. This new airship is at present the most rapid one in the world. Its four motors of 75 h.p. give it a speed of 60 kilometers an hour. The *Zeppelins* and the *Parsevals* can only obtain a maximum speed of an average of 50 kilometers. The steering apparatus is regulated by the mechanical displacement of water contained in the tubes below the envelope. The airship has 4 searchlights, is 90 meters long, and carries 15 passengers.

—*United Service Magazine*, February, 1910.

Passenger Airships.—The choice of a suitable landing station for Zeppelin airships in Cologne was the subject of a long conversation this month between Herr Colmann, Director of the Zeppelin Company, and the Head Burgomaster of Cologne. As regards the project for the establishment of Zeppelin airship lines, it is stated that a Zeppelin airship for touring purposes, 300 m. in length, is now in course of construction. This gigantic vessel is to be equipped with eight engines. To propel her, at the rate of 10 m. per second, four engines will

suffice, and the other four will be put into operation only in cases of bad and stormy weather. The first regular airship line to be opened is to run from Hamburg via Cologne to Baden-Baden, and the second from Hamburg to London. At the present time the activity of the above company is being centered, as far as manufacturing is concerned, on the production of vessels for passenger traffic. The German Ministry of War will, it is said, not purchase any more dirigibles for the present, and intends to await further developments in the perfection of aeroplanes. It is reported that the German airship maneuvers are to commence in February in Metz.—*The Engineer*, February 4, 1910.

Long Wireless Transmission.—A remarkably long wireless transmission was recently recorded by the steamship *Tennessee*, five days out from Honolulu, which succeeded in catching a message from Table Bluff on the coast of California. The message was a weather report, which was afterward verified by the Navy Department. The distance of transmission was 4,580 miles.

—*Scientific American*, March 5, 1910.

A New Voltmeter.—In a recently invented voltmeter, permitting the measurement of tensions up to 200,000 volts, air compressed to fourteen atmospheres constitutes the insulation, as oil would not be suitable for currents of such high pressures. The tension necessary for perforating a layer of air compressed to fourteen atmospheres is stated to be 400,000 volts per centimeter.—*Compressed Air Magazine*, February, 1910.

Application of Electricity for Purifying Air.—New applications of electricity are being discovered daily but not every new application is of such interest or importance as one recently developed for purifying the air of reading rooms, theaters and other close places where large numbers congregate. The apparatus referred to is the ozone generator made by the National Air Filter Co., Chicago, a large installation of which was recently made in the Chicago Public Library to purify or ozonize the 10,000 cubic feet of air per minute that is forced into the main reading room. Dr. W. A. Evans, Health Commissioner of Chicago, declared that the air in the library building prior to the installation of the apparatus was entirely unfit for use, being foul and dangerous, and probably no other building in the city has been subjected to more condemnation because of its defective ventilating system than it. After the installation of the ozonizing apparatus it was found that the main reading room was completely deodorized, the air being freed of that disagreeable and deleterious odor which for years had so thoroughly permeated all papers, books, furnishings, etc., in this large room. The fresh sterilized "mountain" air in the room reduced the humidity during the hot, oppressive days of summer, and greatly increased the comfort of the readers and employees. The installation renders the disinfecting of all books, periodicals, papers, etc., on the shelves, racks, tables, etc., an automatic process, keeping them constantly in a hygienic condition.

The ozone generator is installed in the large air duct and measures 6 feet high, 11 inches thick and 1 foot wide; it consumes 6.5 amperes of current per hour while ozonizing 15,000 cubic feet of air per minute. A connection is made with a feed wire of 110 volts to a step-up transformer which discharges a current at a potential of 7,000 volts. The high-tension current feeds into a series of electrodes made in the form of ordinary hairbrushes. A static electrical discharge is maintained playing against a series of glass plates. Through

this blue electrical discharge of 7,000 volts, air is forced, the result being that all bacteria, germs, etc., are electrocuted. When the filtering electrodes become dirty or clogged they are simply rubbed together and cleaned as one would clean an ordinary hair brush. The generator is placed between the fan and the spray of water used in washing the air, to prevent losing the ozone which the water would otherwise naturally take up.

The low consumption of current and consequent low maintenance cost makes the ozone generator feasible for purifying the air of shops, mills and factories where difficulty is experienced in supplying air in large volume free from odors. It is of commercial importance for preserving and restoring food and other products affected by odors or quickly tainted by decay. Ozone has been found to completely deodorize stale milk, cream, butter and other creamery products, and other uses for the process are constantly being discovered. It is being used for aging wine, curing tobacco, tanning hides, purifying water, etc.—*Machinery*, November, 1909.

Aluminum and magnesium were the two earliest metals known to exhibit a rectifying effect on alternating currents, and lately a large number have been added, including tantalum. These, however, may be classified as belonging either (a) to those showing the more general behavior, which consists in the cell developing a film offering a very high resistance to a direct current passing through it in the direction in which the metal acts as the anode, and having a comparatively negligible resistance in the reverse direction, or (b) to those that show the less general phenomenon, in which a similar high resistance is offered, due to a film which forms under the action of alternating current. There are, however, two additional metals, viz., tantalum and niobium, which can be classed with the original two as manifesting the true rectifying effect. Mr. Walter adds tungsten to these. He made the discovery while experimenting with a sealed-in tungsten lamp filament used as anode in a form of electrolytic detector, with sodium chloride solution as an electrolyte. The maximum critical voltage was observed to be about 90 volts with sulphuric acid of 1.15 concentration and with other solutions. In strong acids the critical voltages are as a rule higher with tungsten than with aluminum, but not so high as with tantalum. While the sensitiveness to heating is not at all pronounced, the sensitiveness to the cutting off of current appears to be very great indeed. When an alternating current was switched on, using new tungsten anodes which had never previously been formed, a direct current was immediately obtained.—*The Engineer*, February 11, 1910.

A New Explosive.—An account of a new explosive, the invention of an Englishman, has been given out by Vice-Consul General Claude E. Guayant of Panama.

The inventor's exhaustive tests before the members of the Isthmian canal commission and officials of the republic of Panama, showed that it is absolutely impossible to explode it by ordinary means. It was hammered with a sledge, shot into with a rifle, burned and ordinary dynamite detonators were exploded in it, both by fuze and electricity, but the compound was inert. Not until a special detonator was inserted could the substance be exploded; but then, in a few charges that were set off, it showed itself more powerful than dynamite. It can only be set off by heating a small platinum wire just inside the open end by an electric spark or fuse. It will not explode by concussion. The new explosive is composed of perchlorate of ammonia, nitrate of soda and several

other ingredients, such as paraffine, for water proofing, etc. It is claimed that it is 50 per cent. stronger than the 60 per cent. grade of dynamite, and that the cost of manufacturing will be more than \$20 a ton cheaper.

—*Compressed Air Magazine*, February, 1910.

Alcohol from Peat.—A French chemist has determined that one ton of dry peat will yield 41 gallons of pure alcohol. After the peat fiber is hydrated it is treated with sulphuric acid and is thus changed into a sort of sugar which when permeated by means of a special yeast yields alcohol. The cost of this method of production is said to be about one-quarter that of potato spirits, so that our large supply of peat may lead to a cheap source of alcohol production.—*Compressed Air Magazine*, February, 1910.

Desertions in the German Army.—The *Berliner Tageblatt* makes the following observations with regard to the desertions from the German Army:—

The military courts tried 393 cases for acts of brutality to soldiers, and 190 others for various acts of ill-treatment, but it adds that the number of cases of ill-treatment unknown to the authorities is far larger. As a result there were during that year 735 desertions from the German Army. The cause of these is undoubtedly the ill-treatment to which the men are subjected. The greater portion of these deserters enlist in the French Foreign Legion, of which Germans form a considerable proportion.

—*United Service Magazine*, February, 1910.

The New Automatic Rifle.—As it happens it is not only in this matter that we are likely to follow the lead of Germany, for at the present time the British soldier is placed at a disadvantage with his German confrere in his potential shooting powers. Five years ago Germany adopted a new form of bullet, that pointed bullet, which very considerably increases the chances of a soldier hitting his enemy in time of war. When it is realized that over a distance of 600 yards a bullet from the German rifle has a rise and fall of only three feet as compared with six feet four inches in the case of our own bullet, the disadvantage under which the British soldier would stand on active service must be perfectly obvious. It is suggested that the reason why we are not profiting by the experience of the two leading Continental Powers, is because there is a strong probability of the British Army being armed in the near future with a perfect automatic rifle. If this is correct, and we have the best reasons for believing that it is, the War Office are to be commended for securing for our troops a superiority in rifle fire over every other nation. After considerable experimenting, an automatic rifle has been obtained which satisfies expert requirements, and if its adoption has not yet been definitely decided upon, it is more from motives of policy than anything else. The moment is regarded as scarcely ripe for the introduction of a new arm, but the one in view can be manufactured rapidly whenever it is required for issue. The aimed rate of this new rifle is said to be 100 shots per minute, and the end of the barrel is supported by a fixed folding tripod to secure steadiness.

—*United Service Gazette*, January 20, 1910.

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible, by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

SOME PRACTICAL POINTS IN NIGHT FIRING

By Lieutenant PAUL D. BUNKER, C. A. C.

In view of the fact that it is contemplated including, at least in some cases, night firing with shell tracers in the regular service target practice, and also that this kind of firing is new to most of us, it would seem incumbent upon all persons who conduct such practices to contribute whatever lessons their experience has brought them. In this way "the next fellow" is benefitted because he does not have to arrive at the same facts over the same painful road of experience. In the recent 3" night practice held at Fort Stark, N. H., several things were learned which, if they had been known previous to the firing, would have exercised a favorable influence on the score. They are therefore submitted in the hope that they may be found of use in future firings.

The first and most important of these relates to the method of observation of fire. It was found to be very difficult, if not impossible for any officer at the guns to observe the shots efficiently. This is partly due to the dust blown up from the parapet, and partly to the glare of the powder flames when the gun was fired. It was said that the glare was apt to blind the eyes so that by the time the latter had recovered it was too late to get the full benefit of the tracers. But the principal difficulty follows as an inevitable result of the location of the observer at the guns. This might be described as a lack of parallax with respect to the target and the trajectory in its vicinity. It is evident that this position is a poor one for the estimation of range errors, especially when the projectiles are going over the target.

There is another fact that might help confuse the observer, if he is at the guns. When the projectile strikes the water, the tracer is usually momentarily occulted, probably by spray. If the shot is a good one for deflection, the observer may be tricked into believing that the shot has pierced the target and

has been occulted by it. This for the reason that under certain conditions of site, etc., any shot piercing the target would be momentarily out of sight of the observer at the guns.

Now it is evident that the tracer itself is simply an aid to observation of fire, and unless we are in a position to observe efficiently, we fail to get the full advantage of the tracer. During the firing in question the writer happened to be about 100 yards to the right of the firing point. From this position the flight of the projectiles could be watched to perfection and fairly accurate estimates of the range errors could be made. This position seemed to be especially good for the observation of overs. Hence it would seem that for the observation of range errors a station somewhat to one side of the firing point is necessary. This distance of 100 yards seemed sufficient; more or less might work equally well or even better. On the other hand, this location is nearly useless in so far as it relates to the detection of errors in deflection, and it is doubtful if a position could be chosen so as to allow the efficient detection of errors both in range and deflection simultaneously.

After a thorough discussion of the last practice, a tentative system of observation of fire has been devised and probably will be tried out in our next practice. It consists primarily of a telephone line with head receivers and transmitters, running from the center traverse of the battery to a suitable location about 100 yards to its flank. Some available officer will be at the outer end of this line and will telephone the results of his observations direct to the officer at the battery, who will take the necessary steps to correct the firing. The latter is already in a position to correct for errors in deflection.

In any case, disregarding the particular methods employed, the range observer must be off the flank of the battery. This truth once established, the distance at which he must be established and the specific method of communication employed are questions that must be solved by future experiment.

Another point learned relates to the proper manipulation of the illuminating lights. For 3" firing it was found that a 36-inch light "would do", but it is believed that a real and perceptible improvement would result from the use of a larger light. In handling the light or lights it should be remembered that not all of the tracers will work. In our last practice about 25% failed to "function." Therefore the lights should be maneuvered so that the splash will be illuminated, if possible, thus obtaining some information, at least, about the shot.

During the Fort Stark practice the range observers on the tug encountered serious difficulties in correctly observing overs and shorts. The shore searchlight exercised more or less of a blinding effect on them and the tug was too small to afford them shelter from it. Also, in the dark, it was impossible to get the overs and shorts with any degree of accuracy, as the pins of the range rakes were invisible. The observers were instructed to sight on the target and then place their finger as close as they could judge to the proper place on the range rake (corresponding to the splash) then by the use of a lantern the number of the pin could be read. It would seem that better results could be obtained in districts that are better equipped. The scheme is submitted of putting the range observers on board a vessel that is equipped with a small searchlight or on which a bright battery of incandescents could be arranged. By standing in the bow or stern with the glare of these lights coming at their backs the numbers of the pins could be read and the pins themselves seen without difficulty.

Orders had been received that before each shot an officer must look through

the sight to insure the gun pointer firing at the right target. This tended to slow the fire greatly. The experience of this firing shows that this degree of caution is not necessary. Perfect safety could be secured by indicating the target to the gun pointer and then letting an officer look through the sight to check it just before the record firing began. A gun pointer cannot do his best unless he is let alone, a simple fact that does not receive the attention it should. Also, the latter method would more nearly approach service conditions.

In this connection, it is believed that some arrangements should be made so that officers may have the opportunity of acting as gun pointers for a short string of shots equipped with tracers. It is easy enough to instruct gun pointers in all the niceties of their business, but it is believed that far better results would be obtained if we were actually to perform the work once or twice ourselves, find out by experience the little difficulties incident thereto, and by criticizing our own performances to become better able to appreciate and to correct the errors of our men.

♦ ♦ ♦

Fort Stevens, Oregon, February 21, 1910.

The Editor, Journal U. S. Artillery,
Fort Monroe, Virginia.

Sir.—

Referring to the November-December issue of the JOURNAL, 1909, you will find an article by "System" relative to methods for Artillery Engineers and Ordnance Officers in which a card system is used to keep tab on the work of the men in these offices. Upon reading it the idea came to me to employ it for the extra duty mechanics and post plumber. The system was put into operation at once and has proven most satisfactory. As used the system is as follows.

The cards have been changed slightly. (See Fig. 1.)

Work Order No. Date, ..., 1910
To

Work to be done:

Completed
Inspected

FIGURE 1

All repairs or work of any sort that requires the services of an extra duty mechanic or plumber are entered on the Q.M. repair book in headquarters which I examine daily. From the entries in this book I make out cards and give them to the various men concerned.

In the quartermaster's office is a two-compartment box for each man in which he places his cards when the work noted on them is completed. The cards for each man are numbered serially so that the work may be checked. The cards are either given to the mechanics and plumber by me or they get them from their boxes immediately after artillery drill every morning. The front compartment of each box is for the cards that denote work to be done and the rear compartment for the cards after the work has been finished and the card signed by the man who has done the work.

The mechanics and plumber have orders not to do any work that is not given to them on a card from me so that there is no doubt about what they are to do and how they are to do it. They can easily keep track of their jobs and are never at a loss at what to do next.

This idea, it seems to me, could be used in any department where the duties are not purely routine from day to day. In the case above cited it has worked beautifully and greatly decreased the liability to confusion and mistakes.

Very respectfully,

W. C. JACOBS,

1st Lieutenant, Coast Artillery Corps.



BOOK REVIEWS

An Introduction to Military Geography. By Brig. Gen. E. S. May, C. B., C. M.
G. 6 x 8½. XIV + 274 pp. 20 Maps. London: Hugh Rees, Ltd.,
119 Pall Mall, S. W. Price, 8/6 Net.

This is an enlargement of the work by the same writer, issued a few years ago, under the title, "Geography in Relation to War." The term military geography, the writer says, "regards the geographical features of the earth with a view to military operations; but man has modified the original condition of the ground, and therefore wherever armies meet, topography has to be considered, and the artificial details of a country prove often as important as those of natural origin."

In the introduction, the author points out the respects in which geographical considerations influence military operations and therefore the chief points to be studied in examining a country's military geography. In seizing a base of operations in a foreign country, it may, and probably will, be necessary to land a force on an open beach—necessitating a knowledge of depth of water, direction and force of prevailing winds, character of beach, supplies to be had in vicinity, approaches—these and many other equally important items of information should be known. In operations in an enemy's country, all its physical characteristics become of utmost importance. Its resources, also, should be known to the invader, through this is not as important as formerly, when armies were so much smaller and could for a short time be subsisted on the country. Now, they must provide most of their subsistence from outside—and thus the lines of communication become of increased importance.

Natural and artificial frontiers are discussed in a very interesting chapter. The former can never equal those dictated by "the spread, or ambitions, or necessities of particular races." Most wars of recent date have been connected with frontiers—Prussia with Denmark in 1864; Prussia with Austria in 1866 and Germany under the leadership of Prussia in 1870; Russia with Japan in 1904. The danger of trouble which may come with only an imaginary line for a frontier separating two states, is at times reduced by treaties creating "buffer states," which the signatories agree shall be neutral to each. Examples of such are numerous and are familiar to all—Switzerland, Belgium, Afghanistan, etc. Protectorates are discussed and the principle, upon which their formation is based, stated. A chapter on European frontiers follows. That between France and Germany is described quite minutely with a sketch map showing the French line of forts holding it. The differences in the preparations made by Germany for a possible renewal of the struggle with her western neighbor are admirably discussed. As are also the features of the Russo-Prussian frontier and the frontiers of Austria-Hungary and Italy. The recent development of Italy's navy is explained by her appreciation of the weakness of her frontiers and the reliance she must, therefore, place on her sea forces. Then follows chapters containing discussions of mountains, valleys and rivers in their

effect upon military operations; canals in Germany, France, Austria-Hungary, Panama; waterways of eastern Asia; railways in Turkey, Arabia, and Persia—where locations are governed by political, as well as commercial considerations; Russia's troubles resulting from her lack of seaports, ending with the geographical considerations which precipitated the war of 1904-5.

Three appendices finish the work. The first gives the text of the Anglo-Russian convention of 1907, which settled, as far as a convention could settle such questions, the limits of the possessions of these two powers in Persia, Afghanistan and Thibet. This must be considered as one of the most important political events of recent years. Appendix II gives the new Anglo-Japanese agreement of 1905. Appendix III is headed "A Unique Achievement of Cavalry and Horse Artillery, Rendered Possible by Climatic Conditions in 1795. It is an account of the capture of a fleet of Dutch warships by French cavalry and horse artillery—when the fleet was icebound near Texel.

This is an excellent work in every respect. Paper and print are of the best—up to the usual standard of the publishers. The maps are numerous and well-chosen. If references to the maps had been a little more frequent—that is, as to the particular maps to be consulted to find places referred to—the reader would, in some cases, have been assisted. This is but a detail, however, and is not serious enough to be a criticism.

Three Rivers. The James, The Potomac, The Hudson. A Retrospect of Peace and War. By General James Pearson Farley, U. S. Army. The illustrations are ten sketches by the author in water colors, reproduced in color. The Neale Publishing Co., New York. 5 $\frac{3}{4}$ x 8 $\frac{1}{4}$. 277 pp. Cloth, handsome letter press and binding. Price \$2.00 net, postage 15 cents.

In writing this book, both on account of the subjects selected and the excellence and originality of the treatment, General J. P. Farley has performed most ably a task for which the thinking world will be grateful. For whenever a writer of unusual experiences and opportunities undertakes that most difficult of all literary labors, namely, the recording of reminiscences, he bequeathes (as this able author has done), a literary treasure of great value to mankind. And when there is combined the exact mind of a military writer, with the delicate nicety and keen observation of the artist, as in this instance, a book of such memories becomes of unusual value to history, art and literature.

The more reasonable idea of history is, that it consists no longer of a mere chronological skeleton of events, but it must be clothed also in the warm flesh and blood of the thoughts and impressions of those alive in that particular time. What would the biblical events be without the fragmentary writings of the Jewish and Christian contemporaries? What would Grecian history be without Xenophon or Herodotus? What Rome without Caesar, Pliny and Horace? What England without Pepy's Diary and Addison? Our Revolutionary era without its letters and diaries? What the Civil War without the quaint letters of Lincoln, the memoirs of Grant, the irony of Nast in cartoon and print? These and these alone reveal the influences, the consequences, the feelings, the spirit of each age that they represent, and by writing a book of memories, General Farley has put himself in the same category.

The three rivers, James, Potomac, Hudson, are made to run like silvery threads of memory through the writer's theme and on these with poetic skill he has built rare descriptions of men and times and historic landmarks, with which in his active life the author had become intimately acquainted.

As a constant visitor in the state of Virginia, General Farley was naturally

sympathetic with the South, at least his warm heart sided with his boyhood's friends, but before he could leave West Point, where he was a cadet, circumstances had kept him loyal to the Government and so his sword like that of his father and grandfather was drawn under the same glorious flag. The impressions therefore that are given in the book are those of a Federal officer tempered with the sweet and lofty kindness of one who loved his foe, resulting in a narrative as unique as it is beautiful.

Let us briefly sketch the main subjects of the book,—there are given a new and thrilling account of that epoch-making battle between the Monitor and Merrimac; an impression at first hand of the explosion of the Petersburg mine on July 30, 1864; some criticisms of Bull Run; a description of the explosion of the ordnance barges at City Point Wharf, August 9, 1864, when the life of General Grant was in extreme danger; and other occurrences of equal importance pertaining to the Civil War period.

There are also given the earlier recollections of President Pierce and a famous interview regarding a "big stick" in 1853; description of some famous old homes in Washington; a vivid recital of the explosion of the great gun "Peacemaker" on board the Princeton, February 28, 1844, when President Tyler was barely saved from death, while six famous officers of that time were killed. These episodes are touched with the pen of one who knows not only how to write, but also to interest while he instructs.

The major portion of the volume is devoted to West Point—the new and the old, when the author rises to his greatest heights of excellence while narrating the olden scenes, the famous lives, the events that certainly were making history.

Traditions of the Hudson River, especially as recounted in Irving's works, and in Revolutionary literature occupy a portion of the book. The dramatic escape of Benedict Arnold after his treachery, while Washington was visiting unexpectedly the Arnold household is an excellent description of that dastardly crime of American history.

In the chapters on Art in the Army, Art at West Point, we have recalled to our minds such interesting characters as Gimbrede, Thayer, Weir, who were teachers at West Point in the past regime; and some of the writings and an appreciation of Colonel Larned of the present time are also presented for our study.

There is also a most interesting account of the West Point days of James A. MacNeill Whistler, and a sketch of the course of events culminating in an examination question and the fated reply that "silicon is a gas," which doubtless deprived our country of an able officer, and certainly gave to the world the greatest of modern masters of art.

Art and artists at Fort Monroe Club are referred to, and officers whose achievements in painting or drawing are worthy of note are mentioned by name, not so much to exalt men as to show the world that the soldier's life is not of necessity a narrow one.

The work is brought to a most fitting conclusion as a book of remembrances by the addition of several chapters containing some splendid criticisms of art, written by the author's father, Lieutenant John Farley. The printing of these literary gems on the part of the author is a favor to the readers of the volume, a duty to the merit of the parent and a splendid tribute of a literary son to a literary father whose genius was recognized in a past generation.

If one wants to know a man, cultivate his friendship; if one wants to appreciate a book, read it closely and carefully. As some men are worth

knowing more than others and because their characters, their lives are greater and broader, we strive to know them better; so some books have a quainter humor, a more vigorous, virile style, like rich mines the deeper we delve, the richer the ore, such books bring richer blessings with their acquaintance—these are the books "worth while" and in this class, without fear or favor this able book of General Farley may with all justice be placed. As the rivers bear their rich commerce to all lands, so may the "Three Rivers" carry rich cargoes of artistic memories to all people and all times."

The War of Secession, 1861-62. Bull Run to Malvern Hill. By Major G. W. Redway. London: Swan Sonnenschein & Co., Ltd. 5 x 7½. 392 pp. Price, 5s.

In this admirably written work we are able to see the great American conflict through the eyes of a disinterested and competent critic, in the person of a British army officer.

The author's choice of titles is a deliberate one, for he contends that this was not one of rebellion or insurrection, but one of secession, under color of law and as far as form went, legally accomplished.

In the succeeding chapters we follow the author with interest, while he points out how the geographical and political situations were a contributing course in the conflict; that, as in England during the Boer war, there was a woeful lack of system or military preparedness on either side; that the volunteer armies were volunteer in name, but conscript in fact; that the backbone of all armies is the trained non-commissioned officers, the man "used to looking squarely into the eyes of his men and seeing his orders instantly obeyed" and that the successful military system will be the one that trains the greatest number of this class of men in time of peace. The author very aptly sums up his argument on this subject with the remark "A major-general can afford to be affable, but a sergeant never, a lieutenant on occasions may unbend, but not so a corporal." In pointing out that the greatest number of successful officers in the Federal army were from the artillery, the author but emphasises the thoughts of many officers now in that favored arm of the service.

That it is often sought to make policy and strategy go hand in hand and especially so in this war: this lead to disaster, for after policy had determined that war was to be declared, then strategy should have been allowed to govern until a successful issue was had. Policy may dictate certain things, but a commander in chief is culpable, who accepts such dictation without protest, when he knows the laws of strategy are violated.

For instance the policy of both governments dictated that the theater of war should be in territory adjoining the respective capitals, while strategy demanded rather, that, such a movement as the opening of the Mississippi by the Federal army be undertaken in force, while the south should have concentrated all available forces on the inner lines and attempted a crushing and lasting defeat when first attacked. During the years 1861-62, there appears to the author, to have been an entire lack of strategy manifest on the part of the leaders of both sides; every movement was made in a haphazard sort of a way with only hopes, for a favorable result. The fighting during these years he thinks shows the result of lack of training and initiative on the part of all officers of prominence and especially among the general officers of the Federals with whom he finds fault for staying so far to the rear and being live generals instead of dead heroes. In fact he thinks the line officers and men did the fighting, evolved the necessary tactics and carried on the war out of their

natural ability and liking to fight. With the two presidents, Lincoln and Davis, the author shows but small patience and blames their lack of strategical knowledge and meddling ways for most of the blunders of this period. For the over-officious politician, whether governor or cabinet officer, he has no good words. The blockade he commends, as a splendid piece of strategy. McClellan, he pities and scorns, as one handicapped by a lack of a ready-made system of raising, organizing and equipping an army, and yet who was always willing for political reasons to promise anything to retain command, but was careful to take it all out in promising and not in doing.

Speaking of equipments the author takes a fling at our Ordnance Department, by showing that America had supplied the British army as early as 1855 and 1857 with breech-loading rifles and field guns, but there were none of these to be had when war broke out at home. In treating of the difficulties of quartermaster, subsistence, engineer and medical departments, during the opening years of the war, the author emphasizes the unpreparedness of all these departments and the story reads very much as if it were written of the same departments in the year 1898. Then follow chapters on the various campaigns with an analysis of the reasons for failure and success of each, with praise where he thinks same is deserved and censure where opportunity offers.

On the whole the work is interesting, readable and well worth study by anyone interested in its subject.

Military Geography. Supplement to Dr. A. Petermann's Bulletins from Justus Perthes' Geographical Institution. Published by Prof. Paul Langhans of Gotha.

This is a new periodical which it is planned to issue monthly. Its aim is the discussion of all sorts of geographical questions in their bearing upon military operations. The October, November, and December numbers are at hand. The contents of the first indicate the general scope of the magazine and contains articles intended to show the necessity for careful study of military geography.

There are also articles on the topography and geographical features of the campaigns around Melilla.

The November number contains a discussion of the line of French forts along their eastern frontier, with an excellent map. The author, Major Friederich Immanuel, 158th Infantry regiment, assigns three reasons for the gap in this line of fortifications, between Toul and Epinal.

1. To bait and lead the German advance through this gap.
2. To be able to deliver flank attacks from Toul and Epinal on the German offensive operations.
3. To use this gap as a line of advance as soon as opportunity offered.

This paper is a very interesting study of French military preparedness, as seen by a German military expert.

In the December number 1st Lieutenant Freiherr von Tettan, a. D., observer with the Russian army, discusses the mistakes of General Kuropatkin, due entirely to unfamiliarity with the terrain in Manchuria. He says that the Russians did not study this terrain prior to the war, while the Japanese soon became acquainted with the points of vantage.

He says this was partly due to the fact that the Japanese were accustomed to mountains, while the Russians found themselves in unaccustomed surroundings.

This magazine is intended to encourage and stimulate the study of the

geographical features of scenes of battles and to teach its importance to all students of strategy. This is not always appreciated at its full value. The object is worthy and bids fair to be well executed.

A System of Free Gymnastics Based on the Swedish System Including Light Dumb Bell Drill. Compiled by Sergeant-Major J. B. Betts, Army Gymnastic Staff. 4½ x 7. 68 pages. 33 il. London: Gale & Polden. Ltd., 2 Amen Corner, Paternoster Row. Price 1s. 6d net.

The first part of this book is devoted to a system of free gymnastics,—calisthenic movements requiring no apparatus,—and so carefully selected as to be sufficient in itself for the all around development of the body.

The remainder of the book is given to exercises with both light and heavy dumb-bells, and is very complete and thorough.

This system is particularly adapted to the military service. It does not require a gymnasium with its expensive apparatus and trained directors, but can be given anywhere and by any officer or non-commissioned officer. Sergeant-Major Betts has kept in mind that the young soldier is but a growing lad and requires light and systematic all-around exercise to give him a well set-up and supple carriage, without subjecting him to strain.

For conciseness, arrangement and treatment of the subject of free gymnastics and as a manual for calisthenics I believe that it is without an equal and I would like to see it in the hands of every company and detachment commander in the army.

This book is well bound in linen, and printed in a clear type with the subject matter methodically arranged with illustrations from life.

Motor Control as Used in Connection with Turret Turning and Gun Elevating. The Ward-Leonard System. By A. Olsson, Chief Gunner, U. S. Navy. 5½ x 8. 23 pages. 13 il. New York: D. Van Nostrand Company, 23 Murray Street. Price 50 cents.

This manual is the first of a series designed to cover the various applications of electricity in the United States navy. The complete series will consist of: Motor Control, Ward-Leonard System; Electricity and Magnetism; Primary Batteries; Storage Batteries; Wire, Wiring, Fixtures, etc.; Interior Communication Circuits and Instruments; Telephones, Telephone Switchboards and Telephone Circuits; The Navy Standard Generating Set, with Notes on Engines, Turbines and Generators; Motors and Motor Control of the Turret Equipment; Motors and Motor Control other than Gun Control; the Navy Standard Switchboard and Switchboard Appliances; The Dynamo Room; The Central Station; The Wireless Station (on shore); The Wireless Station (afloat); The Searchlight and Controlling Apparatus; Arc Lamps; The Dynamo Watch, Duties of Attendants, etc.; The Daily and Quarterly Tests; Testing Instruments and Their Uses; Notes on the General Care of the Plant, Cleaning Stations, etc.; Useful Formulas and Tables.

The manual at hand gives a clear explanation of the principles of the Ward-Leonard System of Motor Control together with a detailed description of its various methods of application and operation in turret turning and turret gun elevating. The subject is handled in a concise and simple way and is adequately illustrated with excellent wiring diagrams.

The omission of any reference to the most important troubles incident to this system of control, with the methods of isolating and remedying the same, detracts materially from the practical value of the manual; however, as

presented, it should serve as a valuable practical guide for those interested in the application of the Ward-Leonard system of motor control to turret and turret gun work in the United States navy.

Handbook for Non-commissioned Officers of Infantry. By Captain M. B. Stewart. 8th U. S. Infantry. $4\frac{1}{2} \times 6$. 106 pp. 12 il. Franklin Hudson Publishing Company, Kansas City, Mo. Price 50 cents.

This little book of one hundred and six pages is from the versatile pen of the author of "The Nth Foot in War," and is a compilation of the duties and privileges of non-commissioned officers as found in the "Army Regulations," "Infantry Drill Regulations," "Service of Security and Information," "Organization and Tactics" and "Guard Manual," besides a chapter each on First Sergeant and Company Quartermaster Sergeant. As may be readily supposed, the book is full of useful information from cover to cover and as a time saver for non-commissioned officers and others in search of information will prove valuable. It is hoped that Captain Stewart may find time to enlarge later editions, and add to each chapter some valuable information, taken from his long experience, as to the practical working out of the general rules laid down. For instance, it is important that a non-commissioned officer traveling in charge of prisoners should exercise "every precaution to prevent their escape," but, what must he do when he is ordered by the conductor of his train to remove the handcuffs from a desperate prisoner, or get off the train, as having violated the rules of the road, by allowing them to remain on, etc. We have no doubt that Captain Stewart can enlarge on his work along the practical lines and make it of even greater value than at present.

The Fourth Dimension Simply Explained. A collection of Popular Essays with an Introduction and Editorial Notes by Henry P. Manning, Ph. D., Associate Professor of Mathematics in Brown University. $6 \times 8\frac{1}{2}$. 154 pp. 82 il. Munn and Company, New York. Price, \$1.50 net.

The best of the non-mathematical essays on the subject of the fourth dimension which were submitted in competition for the five hundred dollar prize offered by the *Scientific American* have been issued in this book. The excellent introduction explains the different view points. Explanatory notes are added where necessary for clearness or to correct error.

There are two army officers represented: Lieutenant-Colonel Graham Denby Fitch of the Corps of Engineers, whose essay was awarded the prize, and Major Wilmot E. Ellis of the Coast Artillery Corps.

Equations involving two unknown quantities may be represented by lines in a plane. Similarly, equations involving three unknown quantities may be represented by figures involving three dimensions. Here the relation between algebra and geometry, as we ordinarily understand geometry, ends. We can readily assume algebraic equations involving four unknown quantities, which, by analogy, would involve a fourth dimension. But our language, suitable for expressing algebraic results in which there are three unknown quantities in terms of physical measurements, has no words to express the results from four unknown quantities and when we try to apply our familiar terms thereto the result expresses conditions absolutely beyond our comprehension. The expression of this fourth unknown quantity as a "fourth dimension" is probably the least confusing of the results.

It readily appeals to the imagination what wonderful powers we possess in our ability to handle objects in our three dimensions as compared with sup-

posed beings living in a plane and unable to conceive of more than its two dimensions. By analogy the essays explain the wonderful powers that a being expert in handling matter in four dimensions would have over us. The explanations are certainly as simple as is possible with this subject and the many points of view from which the subject is presented make it a very complete popular work.

Little Rimes of the Garrison. By Birdie Baxter Clarke, Franklin-Hudson Publishing Co., Kansas City, Mo. 5½ x 8. 139 pp. Illustrated by the Author. Price, 1.25.

This volume of verses is of interest to all the army, both officers and enlisted men; first, because it was composed by an army woman and secondly, because all the verses deal with topics of interest to the army at large and in particular to the Coast Artillery Corps. The verses are on apt subjects and reveal the keen eye of the discreet observer and the pleasant mood of the humorist. Much care has been observed in the selection of words, and yet wherever possible, the spirit and vernacular of the barracks have been preserved.

Some of the verses which will appeal to the readers of the JOURNAL will be: "When the Big Guns Shoot"; "The Engineer's Christmas Dream"; "An Impromptu Fourth"; "A Toast to the Ninth Torpedo Company"; "When Fire Call Blows"; "Plantin' Mines"; "Overcoats"; one of the wittiest of the collection being, "A Bum Bugler"; and one of the best, "Stub's Request."

Two selections relate to Fort Monroe, one, a boy's experience with "The Provo," relating the pranks of an army boy amid the casemates, and the moat with its "good fishin'"; the other is entitled "Fort Monroe."

There are also found in the volume quite a collection of limericks, in the composition of which the authoress has developed quite a talent, as all the topics pertain to the army, they are of interest.

Coast Defenses of Countries Foreign to Germany. By Captain W. Stavenhagen, Royal Prussian Service. 6 x 9. VIII+88 p. 7 maps. E. S. Mittler & Son, 68-71 Kochstrasse, Berlin, Germany. Price M4.

The author discusses the system of coast defense of Great Britain, United States, France, Japan, Italy, Austria-Hungary, Russia, Norway, Sweden, Denmark, Holland, Spain, Portugal and European Turkey.

He describes the places fortified, mentions the types of batteries, guns and obstructions, and gives the number of men and field guns available both in peace and war.

He also mentions the number of battleships, cruisers, torpedoboats and submarines of each country considered.

A tabular statement appears giving the number and tonnage of battleships and cruisers of the leading powers. The table also shows the strength in May, 1909, of these countries in ships launched since 1890 and also the strength in May, 1911, in those launched since 1897.

There are a number of good sketches showing fortifications in various countries, for protection of cities, harbors, or roadsteads. These add materially to the work and it is to be regretted that there are not more of them.

The work would be useful to anyone who desires to know what steps countries, other than Germany, are taking in providing an adequate coast defense. The information given is necessarily limited, as nations, generally, guard closely information concerning their permanent defenses.

The Tactics of the Three Arms and Its Modern Conditions. By Luigi Giannitrappani, Captain of Artillery (Italy). 6½ x 9. *Revista di Artiglieria e Genio*, Tipografia Enrico Voghera, Via Astalli 15, Rome, Italy.

This pamphlet is the result of the study of tactical conditions in the use of the three arms of the service; that is, infantry, cavalry and field artillery—based on campaigns that have taken place since the Franco-Prussian War, 1870, and the development from that period to the present day.

The wars which are mentioned and which help the author to his conclusions are, besides the Franco-Prussian, the Russo-Turkish, 1877-78, the Anglo-Boer, 1898, and the Russo-Japanese war.

The pamphlet is very clearly written and the subject matter placed in a very excellent manner. The most important chapters are: No. 1.—On the lessons obtained from the Russian-Japanese war and the tactical use of machine guns as employed in that war. Also the use of cavalry and field artillery is treated therein. The use of hand grenades and the employment of heavy artillery in the Siege of Port Arthur is included in this part.

The second chapter of the book relates entirely to deductions made by the author on the use of various kinds of machine guns.

The third chapter relates to modern field artillery material and what has lead up to the adoption of such material.

Chapter four relates to the use of heavy artillery and its organization and tactical use in siege work.

The second part of the book represents the authors ideas on what future tactics may develop into.

Chapter five on the employment of infantry in battle.

Chapter six is the same as regards cavalry.

Chapter seven is devoted to the action of artillery in battle.

Chapter eight is given over to the use of Field Fortifications and its uses by the attacking army as deduced from the Russian-Japanese War.

Chapter nine is devoted to the author's ideas of what the probable employment of large fighting units would be in future wars

The excellent article by Captain W. A. Mitchell, C. E., in the *Journal of the Military Service Institution* for January-February, is reprinted in pamphlet form. We acknowledge receipt of a copy.

Captain Mitchell's plan provides for an organized, trained and equipped body of 300,000 men ready for war; 100,000 in the regular service, 200,000 in the militia reserve. The latter body is to be formed of state organizations as at present, its efficiency being increased by a mixture of ex-officers and ex-soldiers of the regular service, whose presence in the militia is to be guaranteed by the fact that while so serving they are to draw retired pay at the rate of two and one-half per cent per year of service in the regular forces times their pay at date of retirement. The number of enlisted men thus provided for in the reserve is estimated at 100,000, their average length of service with the regulars, at four years, and their average retired pay, at \$24 per annum. The remaining personnel of the reserve are to be obtained as at present and they are estimated to have had no training. Enforced retirement, age limits for various grades, and a reduction in final retired pay are features of the plan.

Captain Mitchell presents an array of figures drawn from our appropriations for pensions, and concludes that the plan he suggests will involve a total increase of less than \$4,000,000 in our annual appropriations. If the plan is extended to provide the extra officers needed by the Regular Army and the

cost of this deducted from the figures already given, he finds the final total increase to be \$2,275,000 for 200,000 men and 1,848 officers.

The deductions from some of the figures presented in the article may permit of discussion. Our forefathers and their faulty military policy are charged with a no less sum than \$10,000,000,000, not counting the tremendous loss of life and property incurred by our previous wars. It is rather difficult to feel the convincing force of such figures, but if they will tend to the improvement of instruction throughout the country, as to our military needs and the advantages of military training, their effect cannot but be beneficial.

A pamphlet, entitled *Le Revers de la Revolution*, has been issued by the Russian Journal *Golos Pravdy*, in which it is attempted to prove that the insurrection in Finland in 1905 against the Russian Government was inspired by the Japanese Government and that arms and ammunition for its support were paid for by the Japanese. A considerable amount of correspondence is given which is claimed to have been exchanged between Colonel Akachi, the former Japanese military attaché at St. Petersburg, and Russian agents of the insurrectionists. Some of these are signed with the Japanese officer's name, tho most of them are not so. Several *fac-similes* of letters are given. From a reading of the pamphlet, it seems not unlikely that the claim made is correct and that the attempt at revolution was assisted by the Japanese government.



MAY-JUNE, 1910

JOURNAL

OF THE

UNITED STATES ARTILLERY



PUBLISHED UNDER SUPERVISION OF THE SCHOOL BOARD
OF THE COAST ARTILLERY SCHOOL

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UNITED STATES ARTILLERY

*"La guerre est un métier pour les ignorans
et une Science pour les habiles gens."*

VOL. 33 No. 3

MAY—JUNE, 1910

WHOLE No. 103

OPERATION OF THE COAST ARTILLERY SCHOOL POWER PLANT

BY 1ST LIEUTENANT OFFNERE HOPE, COAST ARTILLERY CORPS

In the small steam power plant nearly twenty per cent. of the fuel bill is paid to produce draft in the chimney. It is manifestly an economic error to duplicate small units where they can be combined into one central plant by which a greater percentage of the heat energy of the fuel can be utilized. As the result of such a plan of centralization the Coast Artillery School Power Plant was designed, and installed, to supply the following demands:

(a) Electrical energy for the interior and exterior lighting of the post of Fort Monroe (exclusive of fortifications).

(b) Power for testing, and other school purposes, for the Departments of Electricity and Mine Defense and Enlisted Specialists, Coast Artillery School; including machine shop (motor driven); two electrical laboratories; the school printery and bindery; and the carpenter shop; also to supply power to operate a sawmill for the Post Quartermaster's Department.

(c) Live steam, at 125 pounds pressure, direct to the laboratory of the Department of Electricity and Mine Defense, to operate reciprocating and turbine engines.

(d) Steam heating, either live or exhaust, for the entire school.

(e) For instruction of the student officers and enlisted men of the Coast Artillery School.

A description of the machinery and installation of the plant appeared in the JOURNAL for March-April, 1910, to which the reader is referred.

Although power was generated, and light supplied to such buildings and street lamps as were daily being added in circuit during the month of December last; it was not until just prior to January 1st, 1910, that the entire installation was completed; so that the data obtained from the operation of the plant for the three months of January, February, and March, are herein given. It is seen that the demands upon this plant are more complex than those usually made upon an army power plant. From the beginning it was attempted to keep complete records of the operation, not only to observe whether the daily performance of the plant fulfilled what might be expected from the apparatus as the result of tests, but to determine the economy of the plant as an investment to the Government. These records were also necessary in order to segregate and apportion the cost of operation properly chargeable to each consumer.

T E S T S

BOILERS

The makers guaranteed an evaporation of 9.5 lbs. of water, from and at 212° F., per pound of dry, freshly mined, anthracite coal, egg size, having not more than fifteen per cent. of ash, at the normal (272 and 100 H.P.) capacities of the boilers. As a result of one complete test, with coal supplied by the Government, and one incomplete test, with coal supplied by themselves, the makers have not completely, up to the present time, met the above guarantee both as to capacity and economy. This department (Enlisted Specialists) made two tests of one of the two larger boilers, and obtained the following results:

	1st test	2nd test
Boiler No.	2	2
Duration of test, hrs.	8	14
Heating surface, sq. ft.	2675	2675
Grate surface, " "	60.4	68
Ratio, grate to heating surface	1/44.6	1/39.3
Kind of coal	Pa. Anth. egg	Pa. Anth. egg
Calorific value, dry coal, b.t.u.	12926	12926
Total coal used, lbs.	6689	14451
Per cent. moisture in coal	2.8	3.17
Total dry coal used, lbs.	6502	13993
Total ash and refuse, lbs	854	2788
Percentage of ash and refuse	13.13	19.9
Dry coal per sq. ft. grate per hr.	13.54	14.7

	1st test	2nd test
Draft; furnace, ins. water	.34	.24
“ uptake, “	.43	.366
“ stack, “	.477	.422
“ ashpit, “	.0	.0
Temperature, flue gas, uptake, °F	523	534
Temperature, feed water, °F.....	55.19	54
Total water fed to boiler, lbs.....	56000	108199
Quality of steam, per cent. moisture.....	2.58	1.64
Water evaporated from and at 212° F, corrected for quality of steam.....	65847	128774
Factor of evaporation	1.207	1.21
Average steam pressure, gage, lbs.....	125	125
Evap. from and at 212° F per lb. dry coal.....	10.12	9.2
Apparent evaporation per lb. coal as fired.....	8.37	7.48
Rated horsepower of boiler	272	272
Horsepower developed	238.6	266.6
Per cent. of builders rating developed.....	87.7	98.0
Percentage of builders economy developed.....	106.5	96.8
Efficiency of boiler and grate, per cent.....	75.1	69.0
Method of firing, (hand)	Spreading	Ribbon
Method of starting and stopping	Alternate	Alternate
No. of cleanings	Two	Three

The area of the grate surface, as originally installed, was 60 square feet, or a ratio of grate to heating surface of 1 to 45. During the month of January the boiler was operated under these conditions, with an average economy of 4.5 lbs. of coal as fired per boiler horsepower hour, at a capacity of 52 per cent. In February the makers increased the grate area to 68 square feet, with a view of obtaining a greater capacity. The results of the complete test made by the makers with coal furnished by this department, gave an economy of 8.57 lbs. and a capacity of 250 horsepower. As a matter of experiment this department concluded to reduce the grate area by bricking over the rear portion of the grate bars with two layers of fire-brick, well sealed with fire-clay, covered with a thick layer of ashes. By successive steps, the area was gradually reduced to the present operative ratio of 1 to 85. This gives a daily evaporation at present of 9.8 pounds of water per pound of coal as fired, or 3.5 pounds of coal per boiler horsepower hour. This experiment is still in progress and will probably determine for these boilers the proper ratio of grate to heating surface to give the guaranteed economy at rated capacity.

ENGINES

Each of the three engines has been tested since installation as required by the contract; as well as having been shop-

tested before shipment. Engines 1 and 2 (250 horsepower duplex compound) were tested soon after installation, after a few weeks of shake-down running in order to adjust bearings. After making complete test on one of these, a confirmatory test was made on the other with the same results; so that the results of the first test, as given in Fig. 1, may be taken as the curve of both. A very high efficiency, as well as low steam consumption, will be noted. The maker's guarantee was exceeded when engines were run condensing, but not quite fulfilled when operated non-condensing. The tests on these two units were conducted by Messrs. Britton and Lamb, engineers for the Quartermaster's Department.

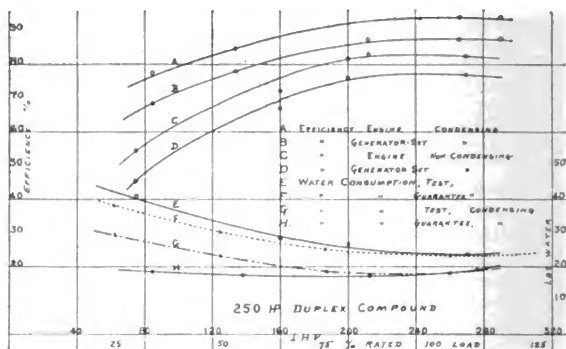


FIG. 1. EFFICIENCY AND STEAM CONSUMPTION TESTS OF 250 H.P. DUPLEX-COMPOUND ENGINES

In Fig. 3 is shown the test curves for the No. 3, angle-compound (120 horsepower) engine, and efficiency curves for the engine-generator set. This test was made by this Department after the engine had been in operation for some time. These curves show a high efficiency, and low steam consumption, and a similar condition as to maker's guarantee as in the larger engines. This engine is of the angle-compound type, cross-section of which is shown in Fig. 2; and was designed to meet the requirement for a small compound prime mover occupying a minimum of floor space, with minimum vibration, and high efficiency. From the operation and tests made by this School, the makers seem to have succeeded admirably in combining all the above desired factors. At full load both cylinders are performing approximately the same duty; so that the tangential force exerted upon

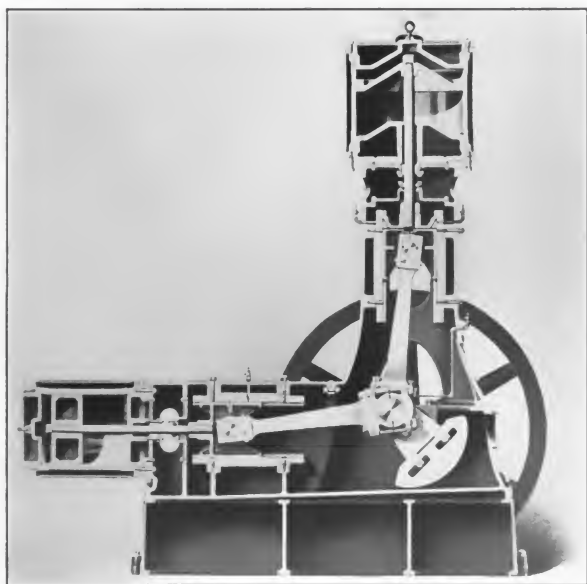


Fig. 2. CROSS SECTION OF ANGLE-COMPOUND ENGINE.



Department of Enlisted Specialists, C. A. S.

TESTING RHEOSTATS. TOTAL CAPACITY, 800 AMPERES AT 240 VOLTS.

the crank is practically constant, as compared with the unequal thrust of the one-cylinder simple engine, and the tandem and duplex compound; thus obviating the necessity of inertia of a heavy flywheel to carry the engine over "dead center."

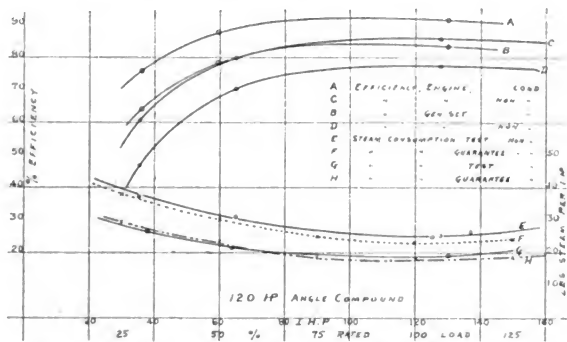


FIG. 3. EFFICIENCY AND STEAM CONSUMPTION TESTS OF 120 H.P. ANGLE-COMPOUND ENGINE

From the indicator diagrams of this engine, the crank effort, or tangential force, is shown in Fig. 4, curve "A" being the distribution of force in the complete cycle of the one-cylinder engine, while curve "B" indicates the same distribution for this compound engine. The same amount of energy is delivered by both, as shown by the shaded portion in the figure.

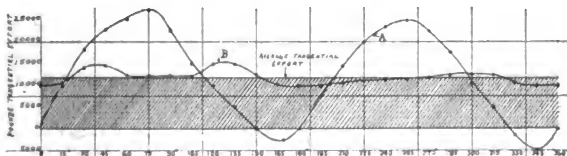


FIG. 4. TANGENTIAL EFFORT ON ENGINE CRANK, CURVE A FOR ONE-CYLINDER ENGINE; CURVE B FOR ANGLE-COMPOUND ENGINE

GENERATORS

These are rated at 150 and 75 kilowatts capacity with two of the former and one of the latter size installed; direct connected to the engines. Speed, 220 r.p.m. for the large units, and 325 r.p.m. for the small unit. A very severe contract re-

quirement was made by the Government with reference to overload capacity, and the makers (Westinghouse Electric and Manufacturing Co.) have installed an exceptionally well built machine.

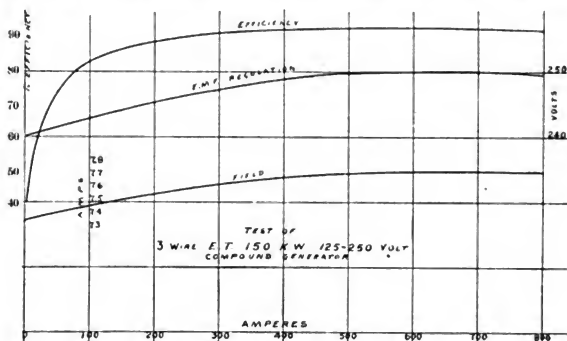


FIG. 5. EFFICIENCY AND REGULATION TEST OF 150-KILOWATT, 3-WIRE D.C. GENERATOR

All of these generators have been tested, as shown in Figs. 5 and 6, each one fulfilling the contract requirement. An over-load of 75%, or 1050 amperes, has been carried for over half an hour on

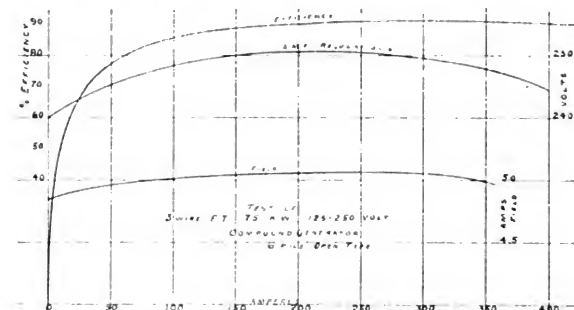


FIG. 6. EFFICIENCY AND REGULATION TEST OF 75-KILOWATT, 3-WIRE D.C. GENERATOR

the larger machine; while a 50 per cent. over-load has been carried for several hours without sparking or undue heating. In order to test these generators and engines a water rheostat was devised,

which was very simple in construction, and gave excellent results. Several empty oil barrels were placed in a row, in which were placed coils of galvanized iron wire (No. 9) of a calculated length to give resistance sufficient for approximately 100 to 200 amperes current on closed circuit for each barrel. Faucets were provided over each barrel, so that a continuous flow of cooling water could be obtained.

STEAM HEAT FOR SCHOOL BUILDINGS

A means of directly measuring the amount of steam used for heating the school buildings was not provided for in the specifications governing the installation. A meter has just been

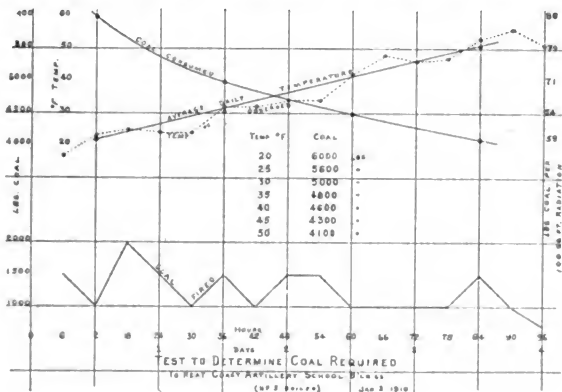


FIG. 7

installed in the return mains, so that in future the condensation from the radiating systems will be metered and the cost directly computed from the evaporation given by daily operation during the heating period. At the commencement of operation it was found necessary to have some means of determining the proper charge to make against the school for the heat supplied from the plant. A 96-hour test was made for the purpose of determining the amount of coal required to furnish steam necessary for the proper heating of the buildings. As seen in Fig. 7, the temperature conditions were ideal for test, giving a wide range with constant rate of change. In making this test the small 100 h.p. boiler was used solely for supplying the steam required in the

heating mains, operated at 125 lbs. boiler pressure, reduced to from 3 to 5 pounds heating pressure in the mains. The capacity of this boiler is slightly in excess of that estimated as sufficient for the amount of direct radiation supplied (7048 square feet, exclusive of mains). Although the evaporation was greater, and a less amount of coal required than would have been the case had a separate boiler been installed, it was considered that this reduction in coal compensated for the decreased loss by radiation when supplying steam from one of the larger boilers in conjunction with power steam; and hence a fair charge to make against the school. From the curve of this test the cost of heating during the past three months has been computed, as shown in the report of operation.

FEED WATER HEATER

A Cochrane open feed water heater is installed in the plant. Two 24-hour tests were made by this Department for the purpose of determining the actual operative thermal saving when using this heater. During the first 24 hours the heater was cut out of service, the plant operated condensing, with feed water supplied from hot-well, to measuring tank, to boiler feed pump, to boiler. Temperature of water taken as it entered boiler. In the next 24 hours, the plant was operated condensing, with feed water supplied from hot-well, to measuring tank, to heater, to pump, to boiler. In the latter case the heater was supplied with heat from exhaust of condenser and feed pumps. The data obtained by these two tests is as follows:

	With heater	Without heater
Duration of test, hours	24	24
Coal fired, lbs	8000	8752
Kw.-hours output	915	908
Coal per kw.-hour, lbs	8.7	9.6
Temperature of feed water entering boiler, °F	200	90
Boiler pressure, gage, lbs.....	125	125

The saving in coal, as shown above, was 752 lbs. for the 24 hours, or .9 lbs. per kw.-hr., or a thermal saving by the use of the heater under similar daily load conditions of 9.3%. Disregarding the variation of specific heat with temperature, for all practical purposes the theoretical thermal saving from the above data would be:

$$\text{Saving} = \frac{200 - 90}{1189.5 - (90 - 32)}$$

or 9.72%. The operative saving was therefore 95.6% of the

theoretical. This illustrates the saving in fuel by using a feed water heater. Not only is there a direct saving, but the increased temperature of the feed water reduces the strain on the boiler shell caused by unequal expansion, thereby prolonging the life of the boiler.

PLANT TESTS AND ANALYSIS

The results of six 24-hour tests made under present operative conditions, three condensing, the other three non-condensing, to determine coal consumption per kilowatt-hour output, are shown in Fig. 8. The average daily plant load for the three months ending March 31st, was 948 kilowatt-hours. The coal used in

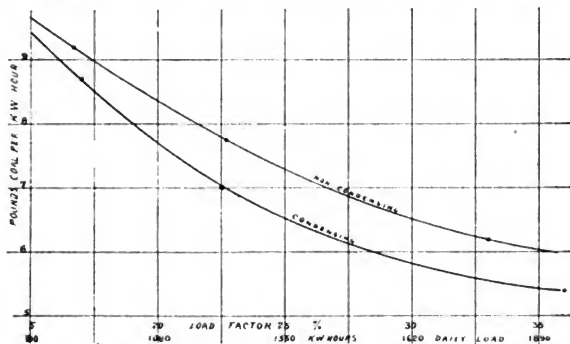


FIG. 8. TESTS TO DETERMINE THE RELATION OF THE LOAD FACTOR TO COAL CONSUMPTION

all tests was the same in heat value (12,500 b.t.u. for "coal as received"). These curves indicate the "influence of the load factor* on the cost of power."

* The "load factor" in this chart (as well as when referred to elsewhere in this article) means the ratio of the output of the generators in use during a given period to the rated capacity of the same generators for the same period.

In the case of this plant, "operating under present conditions," two generators are used, one of 75 kw. and one of 150 kw. capacity. If both generators were run at rated load for twenty-four hours, the daily plant output would = 75×24 plus $150 \times 24 = 5400$ kw.-hours. However, neither generator is operated for the entire twenty-four hours at its rated capacity, but one of the two is in operation at all times. The period during which either the larger or smaller machine is operated is governed by the demand for current.

As there seems to be a somewhat confused understanding of what is meant by load factor, the above explanation of the meaning of the term as herein used is given.

From the tests made, the following plant analysis, efficiencies, and economic data have been obtained:

	Non-condensing	Condensing
Duration of test, hours.....	24	24
Ratio, $\frac{\text{Test load}}{\text{Average daily load}}$ %	187	205
Output, kw.-hours	1773	1940
Engine rated load, %	94	100
Generator load, (as operated), %	90	98
Load factor, (as operated), %	30	35
Coal fired per kw.-hour, lbs.....	6.2	5.4
Exhaust pressure, lbs., absolute	17	2.3
Coal fired per engine h.p. hour, lbs.....	3.55	3.24
Pounds, steam, per engine h.p. hour, lbs.....	24	20
B. T. U. per engine h.p. hour, lbs.....	28560	23790
Engine h.p. hour per kw.-hour	1.74	1.66
Mechanical efficiency of engines, %	84	90
Mechanical efficiency of generators, %	92	92
Mechanical efficiency of engine-generators, %	77	83
Pressure at throttle, lbs. gage.....	124	124
Boiler h.p. hour per kw.-hour.....	1.78	1.54
Load factor of boiler operated, %	52	49
Piping radiation and auxiliaries, loss %	11.8	17.2
Thermal efficiency of engines, %	8.9	10.7
Thermal efficiency of engine-generator, % ..	6.8	8.76
Thermal efficiency of boiler and grate, %	76	76
Thermal efficiency of plant, $\frac{\text{switchboard}}{\text{coal fired}}$, % ..	4.42	5.08
Coal per boiler h.p. hour, lbs.....	3.5	3.5
Cost per kw.-hr. for fuel, cents.....	1.49	1.29
Cost per boiler h.p. hour fuel, cents	.84	.84
Cost per engine h.p. hour, fuel, cents	.85	.77
Cost per boiler h.p. per year, fuel, dollars ..	72.00	72.00
Cost per 2000 lbs. fuel, dollars	4.80	4.80

VOLTAGE REGULATION

Proper voltage regulation at the switchboard is essential to satisfactory and efficient service in a lighting plant. Several tests have been made by the Department of Enlisted Specialists to determine the proper switchboard voltage necessary to compensate for the (IR) line loss to the lamps. Points were selected as nearly as possible on the intersection of the lighting mains and imaginary circles drawn concentric to the power house, where readings were taken simultaneously with switchboard readings. Fig. 9 shows the distributing network of under-ground conduits, and location of street lights, with the voltage drop circles indicated as "A", "B", "C" and "D". Nineteen locations for making

these tests were used, and fifteen minute tests made at each point. These tests were repeated on several different days and nights, and gave the same results as to resistance. The voltage "drop" for every 100 amperes load on the system was then computed and plotted, Fig. 10. The average drop of the system was

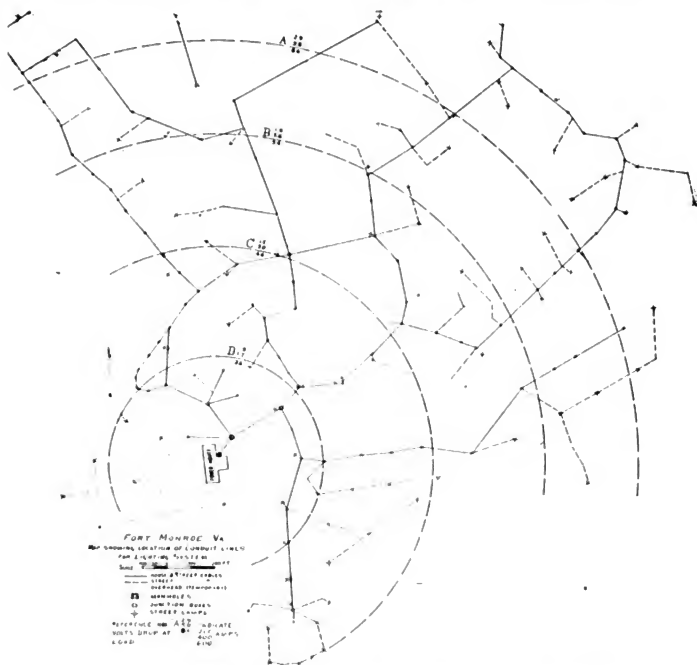


FIG. 9. DIAGRAM OF POWER HOUSE AND DISTRIBUTING CIRCUITS

found to be .9, 1.7, 3.5, and 4.3 volts at 100, 200, 400 and 500 amperes load, respectively; or an average resistance of the entire system of .009 ohms on each side of the neutral wire. A similar test was conducted to determine the average resistance of the street lighting circuit, which is separate from the house lighting. This was found to be .06 ohms, an average of 28 tests made at as many locations, selected at approximately the same points as the

house lighting tests. With the average load of 42 amperes on the street lighting circuit, this resistance gives an IR drop of 2.3 volts for the system on each side of the neutral. The maximum variation of voltage of lamps on circles "A" and "D" (Fig. 9) with the highest average load peak since commencement is 5 volts for the house lighting circuit and 4.5 for the street lighting circuit. The power loss at different loads is also shown in this figure.

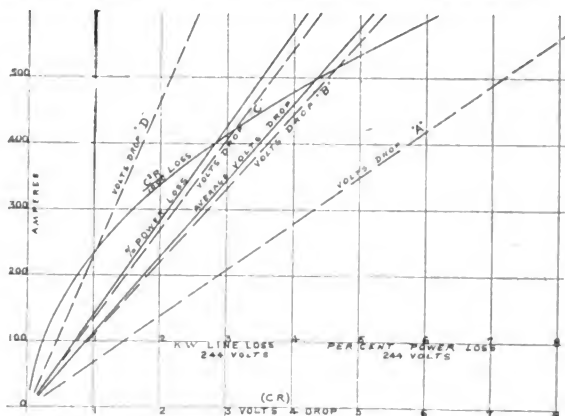


Fig. 10. VOLTAGE DROP AND POWER LOSS OF DISTRIBUTING CIRCUITS

II. OPERATION

Since the first of January the plant has been in operation 24 hours daily, with but two interruptions; one of three hours and five minutes, replacing an automatic relief valve; and one of three hours and fifteen minutes, replacing defective gasket in steam header. The operative personnel consists of three firemen and three engineers, in charge of one master electrician (an assistant instructor in this department); all enlisted members of, and educated for their duties by, the Coast Artillery Corps. No civilians are employed. The day is divided into three watches, or shifts, of eight hours each; one fireman and one engineer being on duty at all times. The hours of duty, at present, are from 11 P.M. to 7 A.M. (1st watch); from 7 A.M. to 3 P.M. (2nd watch); and from 3 P.M. to 11 P.M. (3rd watch). The hours at which the watches change are governed by the load period; and are so arranged that the fireman and engineer on duty during the load

watch (3rd) will have been on duty for some time before the peak load comes on. This permits the fireman to prepare his fires for increased load on the boilers. To equalize the duties of the fireman and engineers, watches are changed weekly (Monday). At this time the day watch for engineers is taken by the master electrician, or an additional electrician sergeant in the School Detachment, and for fireman by a detail of students in the class of Mechanical Specialists; which gives an additional period of eight hours rest in the week.

BOILER ROOM

The fireman is responsible for the proper operation and cleanliness of the boiler room. Although the engineer on watch is responsible for the entire plant operation, better efficiency is obtained by limiting the supervision of the engineer over the boiler room attendants only to cases where it is necessary to prevent accident, or improper attention to duties. During the day period, the students in the class of Mechanical Specialists are detailed in the boiler room for instruction and for general cleaning and repairs. This relieves the regular fireman of the actual labor of attendance, but not his responsibility for proper operation of the boilers and auxiliaries. The following rules and instructions are observed by boiler room attendants:

BOILER ROOM INSTRUCTIONS

Power Plant, Coast Artillery School, Fort Monroe, Va.

1. Upon taking charge, at the beginning of each watch:
 - (a) Blow down water column, note return of water in glass, and test gage cocks until sure of water level.
 - (b) Raise safety valves on each boiler under pressure, to determine whether valves stick on seats.
 - (c) If sufficient water appears in gage glass, open top blow-off cock, allowing it to remain open or not more than thirty seconds.
 - (d) Open front and rear door and examine for leaks in tube gaskets and water leg joints. If leaking slightly, report on log; if leaking badly, report at once to engineer in charge.
2. At least once during shift examine lower row of tubes, looking through furnace door, and note any appearance of bulging or sagging; or if any baffle tile are missing, and report on log.
3. Pumps and injectors will at all times be kept clean and in serviceable condition. At least once during watch start up injectors (if pumps are in use), or pumps, (if injectors are in use), to see that they are in running order.
4. If foaming occurs, check the draft, and open top blow-off freely.
5. In case of low water, (no water in glass, or lower gage cock), cover fire with wet ashes, or with wet coal, if ashes are not available; close fire and ash-pit doors. *Do not open safety valve, or turn on feed-water.* Allow all steam

outlets to remain as they are until boiler has cooled off. Report immediately to engineer in charge.

6. When connecting additional boilers in parallel, or changing over from one boiler to another, do not open nozzle valve of new boiler until its steam pressure is within five (5) pounds (lower) of the one in service. Open valve very slowly.

7. Never close up-take damper entirely with fire on grates.

8. Keep boiler dry on the outside.

9. On Monday of each week, blow off tubes of each boiler in service.

10. Boilers will not be kept in service longer than one month without cleaning thoroughly, removing tube headers, and examining several tubes for appearance of scale. Boilers which have been in service continuously for one month will be cooled down for not less than 24 hours, then washed out and overhauled.

While boiler is being overhauled, gage will be calibrated with test gage

11. The fireman on duty is responsible for all operation and maintenance of the equipment in the boiler room. Cleaning of brasses and re-packing of valves will be done (if possible) during the day watch.

12. All supplies necessary for the boiler room operation will be called for during the day watch, and issued by the store keeper. All repairs needed, or made, will be noted on the log.

13. The boiler room log will be kept by each fireman during his watch, placing his signature on the log in the proper place. Such signature will indicate receipt, by him, of the supplies *on hand* at end of preceding watch.

Anthracite coal, egg size, from the Wilkesbarre district is used, supplied by the Post Quartermaster as needed. Duplicate delivery slips indicate the weight of coal delivered by the Quartermaster to the bunkers. As the coal is fired it is first weighed in the charging wagons (1000 and 500 pounds capacity) at the bunker scales, and the net weight recorded by the fireman on the log, opposite the time at which weighed out. The proximate analysis of the coal now used is: moisture 4.03%; volatiles, 3.17%; fixed carbon, 79.4; ash 13.4%. This is for "coal as received." The calorific value, by bomb calorimeter, is given at 12500 b.t.u. for "coal as received," and 12926 b.t.u. for coal "moisture free." The operative per cent. of refuse and ash runs from 15 to 20. This is due to the fact that there is considerable refuse and dirt in the coal as delivered in the bunkers, as well as the impossibility of perfect combustion with hand firing, however skillfully it may be done. The present cost of coal is \$4.80 per short ton. The fuel cost for the three months ending March 31st has been 91% of the operating, or military, cost of production, and nearly 60% of the operating plus labor cost. It is thus apparent that all efforts to reduce the fuel consumption by the best methods of firing are to be urged if economy is sought. In the hand-fired plant an expert fireman is the one whose proper performance of

his duties gives the greatest returns to his employer. Too often this fact has been overlooked, both in Government and commercial employ. Brains are needed more often in the boiler room than in the engine room; and neither time nor money is ill spent in the proper education of the fireman, upon whose efficiency depends the greatest factor in the cost of steam power.

The capacity of the present coal bunker is thirty-five tons. No provision was made in the original plans for ash and coal handling, except by hand. Plans are now being prepared for increasing the bunker capacity to approximately 100 tons, and for better ash handling facilities; which, when completed, will add to the convenience and economy of operation.

The efforts made by the firemen in this plant to reduce the coal consumption have resulted in a material decrease in the pounds per kilowatt-hour, as shown by the following table. The output given for each portion of the day is the total output for the month for the period indicated.

12 Mid. to 4 P. M. — 16 hours				4 P. M. to 12 Mid. — 8 hours		
	kw-hrs. output	load factor, %	lbs. coal kw-hr.	kw-hrs. output	load factor, %	lbs. coal kw-hr.
January	13100	11.7	15.6	17800	31.9	8.8
February	12908	12.8	12.0	13732	27.2	7.1
March	13792	12.3	12.1	14058	25.2	7.4
Apr. (1-22)	8010	10.0	11.9	9487	23.9	6.9

A boiler room log should be kept in all plants so that those in charge may have at hand data showing the manner in which the fireman performs his duties, and from which to determine where increased economy may be obtained. A log is also useful as a method of instruction for firemen; and, where there are two or more firemen, it provides a means for comparison of efficiency of each, as well as to excite a spirit of rivalry, with increased economy as a result. The boiler room log, as kept in this plant, is appended hereto for the purpose of showing the records kept by the firemen. (See Appendix A.)

As a factor in boiler room economy the use of a combustion recorder, of one of the approved types, is recommended. A Sarco apparatus is installed in the boiler room of this plant. This recorder produces a continuous graphic record of the percentage of carbon dioxide in the flue gas, which enables the fireman to obtain more complete combustion by proper damper regulation. A full description of this apparatus appeared in a recent issue of the JOURNAL (November-December, 1909, p. 313.)

ENGINE ROOM

The engineer on watch is in charge of the plant in the absence of the master electrician. He observes the following:—

ENGINE ROOM INSTRUCTIONS

Power Plant, Coast Artillery School, Fort Monroe, Va.

1. The engineer on watch is responsible for the operation of the plant. He will not absent himself from the engine room except on urgent necessity, and then only when relieved by a responsible and competent engineman. The engineer will not interfere with the fireman's duties except to prevent accident, or improper operation of the plant.

2. Upon taking charge, at the beginning of each watch, the engineer will enter the wattmeter readings on the log, and note any defective operation of machinery, as a result of inspection.

All data called for by the engine room log will be entered each half-hour in the proper columns. Wattmeter readings will only be made at the beginning of each watch, and when load is changed from one generator to another, or new one cut in service.

3. All material needed for operation will be issued by the store-keeper, and receipted for by the engineer on watch. Signature of engineer at end of his watch will indicate that supplies noted by his predecessor, as being on hand, are correct.

4. All repairs necessary will be noted on log. Minor repairs will be made during second watch, if practicable; but, if necessary, repairs for efficient service will be made by engineer on watch at the time they occur.

5. Hours for street lighting service are indicated on graphic schedule furnished.

6. Voltage at switchboard will be regulated, until further orders, in accordance with voltage chart furnished engine room.

7. Notify Artillery Engineer's Office by telephone when serious ground is indicated by ground lights; make duplicate report on form furnished, sending the original to above office as soon as practicable after ground occurs.

8. Note on log, with time of occurrence, any shut-downs, over-load blow-outs, and grounds.

9. A first-aid package will be kept in the engine room, with bandages and antiseptic dressing for burns. In case of serious accident notify Post Hospital.

At the commencement of operation the matter of switchboard voltage, and its regulation, was of first importance. All the generators installed are over-compounded (see Figs. 5 and 6), the two 150-kilowatt units increasing from 240 to 250 volts, by constant increments, from no-load to full-load; while the 75-kilowatt generator has an E.M.F. regulation of 240 volts to 250 volts from no-load to half-load, then flat compounded to an overload point. The operative tests for voltage drop over the system (Fig. 10) indicated that the generators were too highly compounded. Before these tests were made the switchboard voltage was maintained, at lighting load, at 230 volts across the brushes

(115 volts on each side of the neutral), which was considered sufficient to compensate for the computed IR loss in voltage and deliver normal 16 c.p. carbon lamp voltage (110) at the ends of the feeders. Dissatisfaction with the illumination was at once expressed by the "consumer." This was probably due to the fact that many lamps in use had been burning beyond their useful life, and also because the pressure on the old system had usually been kept above the lamp ratings. The present voltage regulation was therefore adopted (although too high for the carbon lamps installed) in order to give the same illumination as before. A graphic comparison of the voltage regulation of the former lighting service with the present is shown in Fig. 11. These curves are plotted from the records taken by a recording voltmeter at the lamps, the same meter being used for each test, and are

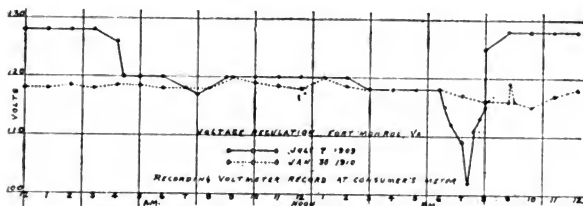


Fig. 11. VOLTAGE REGULATION OF OLD AND NEW LIGHTING SYSTEM, FORT MONROE, VA. FULL LINE CURVE REPRESENTS OLD SYSTEM; DOTTED LINE CURVE, NEW SYSTEM

typical of many records taken. The proper compounding of the generators will be made by this Department as soon as the old lamps now installed are replaced by those selected for permanent use. The pressures maintained, for all loads, on the distribution circles (see Fig. 9), as well as the present switchboard regulation, is shown in Fig. 12. These were plotted from the IR losses given by the curves in Fig. 10.

When the laboratory and machine shop motors are in use during the day, the line current is at times unsteady, for the reason that all except one or two of these motors are connected between the line and neutral, thus causing considerable unbalancing of the generator. An unbalance of 25 per cent. on either side of the neutral will not give more than seven volts switchboard variation between each side of the neutral wire. One hundred and ten volt laboratory motors should be replaced by 230 volt motors.

The switchboard load on the plant for the months of January,

February and March is shown in Fig. 13. Each curve is plotted from the average of the readings at the given hour for each day during each month. The peak is plotted, similarly, from the highest current output each day and the time of such peak each day. The switchboard output at the January peak is equivalent to that required for 2100 16-c.p. carbon lamps. The total switchboard output for house lighting for the three months was 64,535 kilowatt-hours. The total kilowatts delivered, as indicated by the sum of the readings of the "consumer's" meters, were 58,013 for the same period; or a loss of 10% from switchboard to lights.

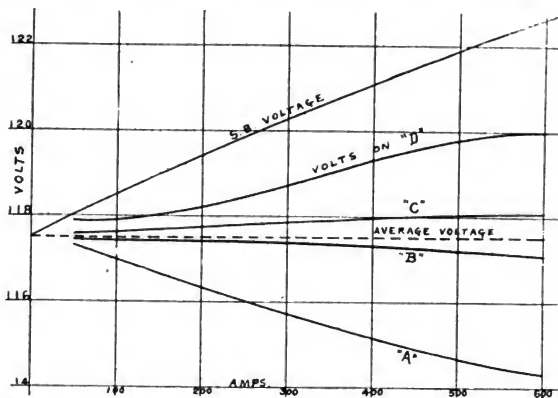


Fig. 12. SWITCHBOARD REGULATION, AND CORRESPONDING VOLTAGE ON DISTRIBUTION CIRCLES (FIG. 9)

Of this loss, from $2\frac{1}{2}$ to 3 per cent. may be accounted for by the C^2R loss of the distributing system, the balance by inaccuracies in meter readings. The low load factor at the peak will be noted.

At present there are 99 street lamps installed; 87 of which are 100-watt tungstens, in multiple, balanced as nearly as possible on each side of the neutral; the rest carbon, or metalized filament, lamps. It was found that the tungstens at first installed on the wharf were too delicate to withstand shock, so that these lamps were replaced by carbons. The current taken by the street lights is from 40 to 42 amperes at a switchboard voltage of from 240 to 242. This gives an average voltage at the lamps of 118.7. A graphic street lighting schedule for Fort Monroe is given in Fig. 14.

This is an "all-night" schedule, with a total of 3932 hours burning for the year 1910. While either the "moon-light," or the Frund, schedules (2190 and 3000 hours respectively) might have been used, with a reduced number of lamp renewals, it is believed that

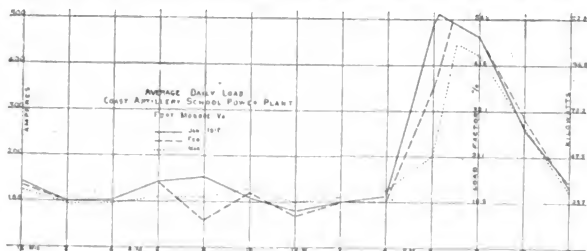


FIG. 13

the New York, (4000 hour) schedule is the most desirable for military posts, as it is the most convenient for plant operation and gives more efficient illumination for military purposes. From this chart can be determined the total hours the lamps have been

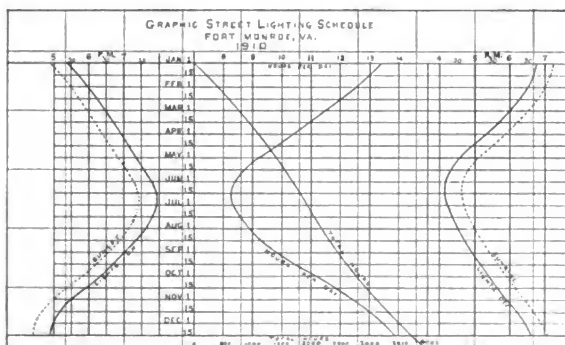


FIG. 14

burning at any time during the year, or the hours burning for any one night. The hours for sunset and sunrise are taken at mean local time, to which is added and subtracted thirty minutes for lighting hours for each night. Instead of changing the time each day, the change is made on the first and fifteenth of the month;

for the reason that more efficient, as well as the most convenient, service can be had by having a fixed time for turning on or extinguishing the lights each night. The power consumed by the present system of street lighting, with a much greater illuminating area, is 10,000 watts, as compared to 20,000 watts of series arc lamps, which it replaced.

The 75-kilowatt unit was operated for 18.5, 19.5, and 21.5 hours per day during the months of January, February and March, respectively. During the remaining hours of the day (peak load period) the 150-kilowatt generator was in service. During the summer months, especially during the two months when the School is not in session, it is believed that the 75-kilowatt set will easily carry the lighting load for the 24 hours. During the quarter ending March 31st, 1909, the power purchased (at 7 cents per kilowatt-hour) for house lighting purposes for this post amounted to 52,567 kilowatt-hours, or 5446 kilowatt-hours less than was consumed for house lighting during the same quarter of 1910. This is an increase of ten per cent. over last year.

The only difficulty met with up to the present time in the operation of these generators is in the prevention of a sudden voltage variation when the load is changed from the larger to the smaller unit. This causes at times a momentary "flicker" in the lights. The trouble arises from the difficulty in properly balancing the field currents of the two machines when they are operated for a brief period in parallel before "cutting out" the larger unit. There also appears at times, though usually of short duration and infrequent occurrence, a pulsating effect in the lamp illumination. The exact cause of this is so far unknown, numerous tests having failed to confirm any one of several theories.

All power generated is measured on the switchboard by integrating wattmeters, one meter for total power, one for house lighting, and one for street lighting. From the bus bars on the main switchboard, power leads are taken to a power distributing panel, from which is distributed the power required for laboratories, (metered separately), machine shop, printing department, storage battery, etc. In case of emergency, an 80-ampere storage battery is connected to the exterior three wire lighting circuit by using the neutral as a common return. On test, this battery has carried the day load on Sunday for over nine hours. The form of engine room log, as kept in this plant, is shown as Appendix B.

Lubrication troubles occurred during the first month of operation, due to a combination of inferior oil and leakage from

stuffing boxes of the engines into the oil reservoir in the engine bed. A forced feed system of lubrication is used, both for bearings and cylinders. By remedying the defects mentioned, the consumption of lubricating oil was reduced from 55 gallons in January to 12 25 gallons in March. Proper lubrication is of the greatest importance to engine economy, and the best lubricant is cheap at any price. With imperfect lubrication there is not only an immediate direct loss in engine power from increased friction, but a much greater indirect loss in expensive repairs. The proper lubricant for any particular type of engine can only be determined by operative test and not by laboratory analysis. Since January, this plant has been conducting tests to determine the most satisfactory oil for these engines, from an economic and operative standpoint; samples having been submitted from several manufacturers for that purpose. The tendency of most engineers is to use too much cylinder oil; especially is this true in boiler feed pumps, where a considerable quantity of oil will enter the boiler, if using exhaust from feed pumps through an open heater. All lubricating oil is filtered and used over in the plant.

A vacuum cleaner is used each day in the generator room to blow out all dust around the generator windings; and when not in use the engine-generators are covered to prevent dust accumulating on them. The concrete floor in the engine room has been covered with a concrete cement filler, and then painted over with a pigment cement paint. By these means commutator troubles due to dust particles from the floor and walls have not been experienced.

During all of January and February, and for the first 23 days in March, steam heat was furnished the School buildings from the plant, 24 hours per day. For the first twenty days in January this heat was supplied by live steam, through reducing valves from the boilers to the mains, delivered at a pressure of from 2 to 5 pounds. During the rest of the period exhaust steam was used. The effect of live steam heating on the coal consumption for January is shown by the records. During the first twenty days in January 12.54 lbs. of coal were used per kilowatt-hour, with live steam heating; while for the last eleven days of the month, with exhaust steam heating, 10.09 lbs. per kilowatt-hour were used, or a reduction of 2.45 lbs. per kilowatt-hour. The temperature was practically the same for both periods. When using exhaust steam, the pressure in the heating mains is regulated by means of an atmospheric relief valve; usually at from 2 to 4 pounds. The three engines installed are designed to

operate with 5 pounds back pressure (above atmospheric) when operated non-condensing.

As supplies are furnished to the plant by the supply departments, they are placed in charge of a storekeeper, and kept in suitable store-rooms. When needed in the engine or boiler room they are issued in small quantities at a time and receipt taken from the engineer or fireman on watch, who enters the amount on the log. By this means an accurate record is kept of the quantity used; and it also serves as a check on wastefulness. A monthly report of supplies used is made by the storekeeper on the form shown. (See Appendix C.)

A graphic log of operation is kept which shows each day the amount of coal used, the output for house-lighting, street lighting, power, and total, the load factor, coal per kilowatt-hour, and cost in cents per kilowatt-hour for fuel and water. By this log a daily comparison is made graphically of the operation and affords an interesting as well as instructive record. The log for February is given (Fig. 15), as an illustration.

III. ECONOMY

The complete cost of the machinery is given in the following table. The cost of the building is not added to this cost, for the reason that the machinery is installed in the space which had been provided for a school laboratory plant, and therefore the depreciation of the building, as well as first cost, is more properly chargeable to the School than to the plant. The costs of the separate units are as low as those paid for commercial installations of this kind.

	Boilers	Engines	Generators and switch- boards	Piping and all auxili- aries	Total Machinery
Capacity	644 b.h.p.	620 h.p.	375 kw.		
Per boiler h.p.	\$14.55	\$18.25	\$14.40	\$18.30	\$65.30
Per Ind. h.p.	18.00	19.00	15.00	19.00	68.20
Per kilowatt	25.00	31.40	24.75	31.50	112.52
Total cost	9377.00	11761.50	9276.87	11794.18	42209.55

A monthly and quarterly report of operation is made. The form of this report, with the data filled in, for the quarter ending March 31st, is given. (See page 261.)

While, in commercial practice, labor and attendance are properly termed "operating expenses", under military conditions, with an enlisted personnel, the labor cost is a fixed quantity independent of output. The only items which may properly be termed "military operating cost" are the cost of fuel, water,

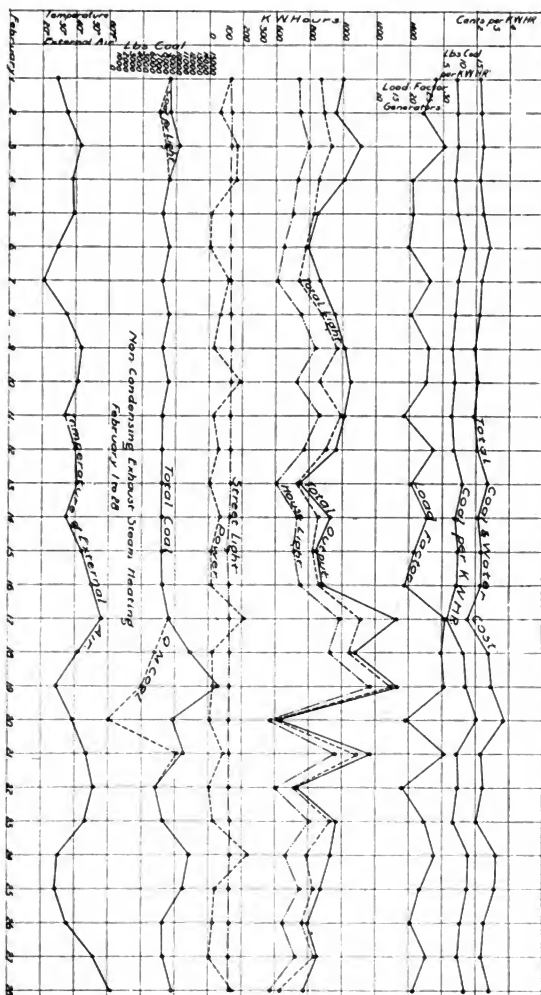


FIG. 15. GRAPHIC LOG OF OPERATION FOR FEBRUARY, 1910

lubricants and waste, and maintenance and repairs. It is upon this cost that the Supply Department must base its estimate for fiscal funds to continue the plant in operation. Three per cent. interest is considered the proper charge which the Government would pay for money with which to install the machinery; and a flat rate of 7 per cent. is considered a fair charge for depreciation of the plant. In that portion of the report termed "Distribution of cost," the cost of the power used by the School for laboratory purposes is added to the total cost of plant operation, laboratory steam, and heating. The Quartermaster's Department is charged in this table with the cost, including labor, interest and depreciation, of all power used for house and street lighting. The thermal efficiency of the plant, in per cent., is obtained by dividing the sum of the heat units delivered to the switchboard in the form of electrical energy and the heat units in the steam delivered to the heating mains, by the total British thermal units in the coal used during the same period. The total cost of operation is higher than it should be for this quarter, due to waste in lubricants and material in a new plant, a larger coal consumption caused by unfamiliarity of the personnel with the boiler economy at the loads required, as well as the period of live steam heating during the first month. For purpose of comparison, the operative data for each of the months, in a more condensed form, is given as follows:

	January	February	March
Total output, kw.-hours.....	30900	26640	27850
Lighting output, kw.-hours.....	28365	24580	22715
Power output, kw.-hours.....	2535	2060	5125
Load factor, generators used, %	18.4	17.6	16.6
Thermal efficiency, plant, %	23.6	32.4	23.5
Total coal used, lbs.....	386600	243583	272122
Coal per kw.-hour, lbs.....	12.51	9.14	9.76
Total water used, gals.....	414024	197457	270620
Oil, lubricating, gals.....	55	20	12.25
Oil, cylinder, gals.....	25	8	4
Operating cost:			
School heating.....	\$350.50	\$296.34	\$241.92
School, plant and laboratory.....	65.42	6.24	52.13
Total, school.....	415.92	302.58	294.07
Light and power.....	606.63	300.16	420.99
Total, plant.....	1022.55	602.74	715.06
Total fixed charges, plant.....	810.66	810.66	810.66
Total cost, operating and fixed charges.....	1833.21	1413.40	1525.72
Operating cost, per kw.-hour, cents:			
School.....	1.34	1.13	1.05
Light and power.....	1.97	1.13	1.52
Total.....	3.31	2.26	2.57
Total operating and fixed charges, per kw.-hr. all charged against switchboard, cents..	5.94	5.31	5.47

OPERATION OF THE COAST ARTILLERY SCHOOL POWER PLANT FORT MONROE, VA.

From January 1, 1910 to March 31, 1910.

CAPACITY		Period	Per day
Rated capacity of boilers installed.....h. p.....		644	
Capacity of boilers in use.....h. p.....		250	
Rated capacity of generators installed.....k. w.....		375	
Capacity of generators in use.....k. w.....		225	
OPERATIVE DATA			
Hours operated:			
Boiler No. 1		984	
" 2		1146.5	
" 3		182.0	
Generator set No. 1		161.5	
" 2		229.5	
" 3		1777.0	
Apparent evaporation per lb. of coal.....lbs.		7.2	
Coal per boiler h. p. hour		4.0	
Coal per k. w. hour total used		10.56	
" for heating		4.24	
" for live steam		.28	
" for light and power		6.04	
Average temperature.....°F.		43.3	
Average temperature for heating period		42.2	
Average steam pressure, by gage.....lbs.		124.5	
Exhaust steam heating.....days.		62	
Live steam heating		20	
Condensing.....		5.1	
Non-condensing		84.9	
Thermal efficiency of plant	%	26.3	
Load factor of boilers in use		45.0	
Load factor of boiler capacity of plant ..		18.8	
Load factor of generators in use		17.6	
Load factor of generators installed		10.6	
Peak load factor.....		52.8	
Average daily curve load factor		23.6	
OUTPUT			
Switchboard:			
Lights, Interior, (post)	k. w. h.	64535	717
Street, (post).....	"	11125	123.6
Power, Laboratory, Dept. E. & M. D.	"	1122	12.4
" Laboratory, Dept. E. S.	"	6041	67.0
" Machine shop, Dept. E. S.	"		
" Carpenter shop, Dept. E. S.	"		
" Printing Dept., Coast Art'y. School ..	"	687	7.4
" Saw mill, Post Q. M., included in house	"		
" lighting	"		
Tests	"	1880	
Total, Light and Power	"	85390	948.7
Live steam:			
Laboratory, Dept. E. & M. D.	b. h. p. h....	2450	
Steam heat:			
To Officers School Building, C. A. S.	b. h. p. h. }	80470	
To Enlisted Specialists Building C. A. S.	"		
To	"		
Total, live steam and heating	"	82920	

OPERATING AND FIXED CHARGES

COAST ARTILLERY SCHOOL											
PLANT			LIVE STEAM			STEAM HEAT			LIGHT AND POWER		
No.	Cost	Cents per k.w.h.	Cost	Cents per b.h.p.h.	Cents per k.w.h.	Cost	Cents per b.h.p.h.	Cents per k.w.h.	No.	Cost	Cents per k.w.h.
Operating cost:*											
(a) Supplies:											
Coal	\$ 39.84		\$58.80			\$852.26					
Water	1.68		2.73			36.50					
Lubricants and Waste	0		0			0					
Total	41.52	.048	61.53	2.6	.072	888.76	1.104	1.04			
(b) Maintenance and Repairs:											
Cleaning material	10.56										
Repairs	10.20										
Total	20.76	.024									
Total operating (military) cost	62.28	.072	61.53	2.6	.072	888.76	1.104	1.04			
Fixed charges:											
(c) Labor and Attendance:											
Master Electricians	1	240.00							1	306.00	
Engineers	1	114.00							2	732.00	
Firemen									2	339.00	
Total	354.00	.427							5	1077.00	1.62
(d) Interest and Depreciation:†											
Interest, 3%	158.22										
Depreciation, 7%	369.27										
Total	527.49	.618									
Total fixed charges	881.49	1.045									
Total cost of operation	943.77	1.117	61.53	2.6	.072	888.76	1.104	1.04			

* Coal for testing and instruction in School charged to "Plant," C. A. School. In this table. (See "Distribution of cost.") Lubricants and waste apportioned on basis of k.w.h. consumption. Maintenance and repairs apportioned on basis of one-half cost of Plant.

† Interest and depreciation apportioned on basis of one-half cost of Plant. Total cost of installation, \$42,200.55.

‡ All expenses of Plant charged against switchboard.

SUPPLIES USED		For Period	Per Day	Cost
Coal:				
Kind, Anthracite, cost per 2000 lbs., \$4.80				
Live steam, Dept. E. & M. D. 18 days	lbs.	24500	1361	\$ 58.80
Steam heating, (6892 Heine coal)		362100	4415.8	852.26
Tests, Department of E. & M. D.	"	0		
Tests, Dept. of Enlisted Specialists.	"	8600		20.64
Tests, school power plant	"	8000		19.20
Light and power (5942 Heine coal)	"	499105	5545.6	1183.83
Total	"	902305	10025.6	2134.73
Water:				
Cost per 1000 gals. 10.5 cents				
For live steam, Dept. E. & M. D.	gals.	26215		2.73
For steam heating	"	347687	4240	36.50
For light, power and other purposes	"	508199	5646.6	53.34
Total	"	882101	9800	92.57
Waste: cost per lb. 8 cents	lbs.	124	1.38	9.88
Oil: cost per gal., lub. 50 cents; cyl. 48 cts.				
Lubricating	gals.	87.25	.97	43.625
Cylinder	gals.	37	.41	18.00
Cleaning material				21.13
Repairs				20.41
Total Supplies				\$2340.35

DISTRIBUTION OF COST		Cost	Cents per k.w.h.
Coast Artillery School:			
Plant operation and tests		\$984.96	
Steam heating			
Steam heating school		888.76	
Dept. E. & M. D. Live steam		61.53	
Elec. Power		38.60	
Tests		0	
Dept. Enlisted Spec. Power		202.58	
Tests		21.44	
Printing Dept. School		23.12	
Total		2220.99	
Total for same period 19			
Increase, decrease			
Quartermaster's Department:			
Post lighting, Interior		2176.19	
Street		375.15	
Power, ...To saw mill (included in house lighting)*			
To			
To			
Total		2551.34	
Total for same period, 19			
Increase, decrease			
Total cost of operation		4772.33	
Total for same period, 19			
Increase, decrease			

Approved:

In charge of plant.

* Not metered separately during this quarter. Meter now installed.

Figure 16 shows, in graphic form, the cost in cents per kilowatt hour, and the cost in dollars, for a daily output of from 800 to 2000 kilowatt-hours. This chart is computed from tests made, with the plant operated under present conditions, and based on the present cost of fuel and supplies.

It is very difficult to obtain the operative cost data of commercial plants of this size; especially of plants where the output is similarly utilized—for heat, light and power. From the data at hand showing the cost of production in four New York office buildings and hotel plants of approximately the same capacity, where the output is utilized in the same manner as that of the

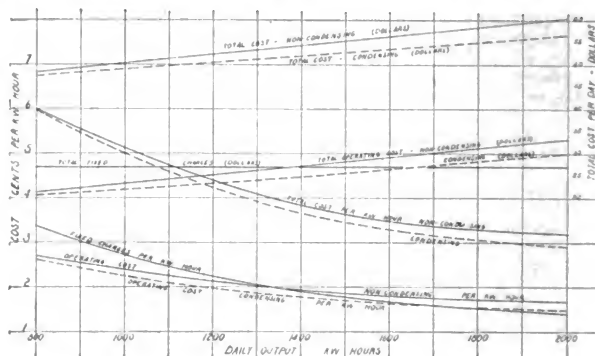


FIG. 16. COST, IN CENTS PER KILOWATT, AND DOLLARS PER DAY, FOR DIFFERENT DAILY OUTPUTS

Coast Artillery School Plant, the following table of comparison is given. The data for the School plant has been given for three different operative conditions, the first line showing the present cost and conditions:

	Capacity kw.	Load factor %	Cost coal per ton	Lbs. coal per kw.-hr.	Cost in cents kw.-hr.
C. A. School plant	225	17.6	\$4.80	10.56	5.6
C. A. School plant	225	17.6	2.85	9.5	4.45
C. A. School plant	225	35	2.85	6.0	3.9
Plant A	260	24	3.00	15.5	5.7
Plant B	575	43	3.25	10.0	4.4
Plant C	300	70	2.10	11.0	3.2
Plant D	260	45	3.00	13.5	7.7

As there are no records of the operation of the old School power plant for the quarter ending March 31, 1909, other than the amount of coal delivered during that quarter to the School by the Post Quartermaster, and the record of light purchased for the Department of Enlisted Specialists, an exact statement of the comparative economy of the plant for school purposes cannot be made. A comparison, however, of the cost of fuel for heat and power, and for lights for the School, for the two periods, under similar conditions as to heat and light, can be made, as follows:

Coal for:	1910	1909
Steam heating (a)	\$852.26	(b)
Live steam to laboratory.....	58.80	(b)
Tests	39.84	(b)
Power to all departments.....	135.01	(b)
Total fuel.....	1085.91	\$829.46
Lights: (c)	\$158.00	\$166.81
For excess current, 1910, over 1909, 2400 kw.-hrs.		168.00
For excess heating, 1910, over 1909, 3500 sq. ft. radiating surface.....		426.13
Total fuel and lights	\$1243.91	\$1590.40
Saving	\$346.49	
(a) For 7048 sq. ft. radiating surface in 1910, 24-hour service. For approximately 3500 sq. ft. radiating surface in 1909, 12-hour service.		
(b) Included in total coal for 1909.		
(c) For 2383 kw.-hours @ 7 cents per kw.-hour, in 1909. For 4783 kw.-hours @ 3.37 cents, in 1910.		

The economy of the plant for post lighting, with similar consumption of power, is shown in the following table:

	1910 (a)	1910 (b)	1909
House lighting, (c)	\$933.77	\$2025.00	\$3513.01
Street lighting	172.45	375.15	780.00
Excess current 1910 over 1909, 3046 kw.-hours @ 7 cents.....	0	0	213.22
Street lighting renewals	86.43	86.43	0.0
Total.....	\$1192.65	\$2486.58	\$4506.23
Saving, 1910, over 1909.....	\$3313.58	\$2019.65	

(a) Operating cost only (fuel and supplies).

(b) Total cost, including labor and interest and depreciation.

(c) Exclusive of school lights. House lighting cost for 1910, based on switchboard output of 59751 kw.-hours. House meter consumption; 53230 kw.-hours in 1910; 50184 kw.-hours in 1909.

It is thus seen that the operative saving for the first quarter of 1910 over 1909 for the School is \$346.49, for post lighting \$3313.58; or a total of \$3660.07 for both. The total net saving,

after deducting the cost of labor, and interest and depreciation, is \$2366.14. It is estimated that the yearly saving of the plant will be approximately \$6000.00, after paying for the labor, (enlisted personnel) and setting aside 10% for interest and depreciation.

While the present economy of the plant, operated at its present load factor, is shown to be considerable, the possibilities of increased saving to the government by the utilization of present available energy, both heat and electrical, are greater.

If the best quality of New River or Pocahontas coal had been supplied, at a cost of \$2.85 per ton delivered in the bunkers, instead of the anthracite coal at its present cost, the operating cost (heat units and price considered) for the three months of operation would have been 1.35 cents per kilowatt-hour instead of 2.75 cents; the total cost decreased from 5.59 cents to 4.45 cents per kilowatt-hour; or a total saving for the quarter of \$994.13. This would result in an annual saving of approximately \$3,000 for fuel. By installing an automatic smokeless furnace under one of the large boilers, all the coal dust and screenings from coal bins and storage yard on the post could be utilized (by mixing it with bituminous coal) giving an additional saving of approximately \$1,000 per annum.

By replacing the old one-voltage tungsten lamps now in use for street lighting with the three-voltage Mazda 100-watt tungstens, the renewals for each lamp would not be more than 2.5 per annum, or a little more than half of the present allowance.

Referring to Fig. 17 it is seen that the heat energy wasted in exhaust steam, when the plant is operated non-condensing, with present daily-load, is more than half of that contained in the fuel. Or, in other words, for every pound of coal fired only 42 per cent. of its heat value is actually used in the plant. As has been aptly stated, "the most profitable load which an engine carries is the back pressure necessary when exhaust steam is sold for heating purposes." The records of this plant for the month of February show that of the total cost for fuel for generating current, over one-half was charged to the School as the amount necessary to furnish steam heat. There is sufficient exhaust steam available, with the present load on the plant, to supply 14,000 square feet of direct radiating surface. If the Artillery School Library, the proposed new Barracks for the School Detachment, and the two new sets of officers' quarters (now nearing completion), were connected to the present heating system it would add approximately 6900 square feet of direct radiating

surface. The heating of all these buildings, in addition to the School, would then be accomplished without additional cost for fuel, above the amount now required to generate electricity, when the engines are operated non-condensing with back pressure. In other words, if the coal which would be required for heating all these buildings with separate steam heating plants was turned over to the power plant, and the buildings furnished with exhaust steam heat, the *lighting of the post would be a by-product* during the heating months.

By utilizing exhaust steam during the summer months, and current as motive power, a six-ton ice plant could be installed (at a cost not exceeding \$10,000, including building), which would produce ice at a cost of forty cents per ton for water and power. The government is now paying \$5.00 per ton.

EXHAUST STEAM 58%	USED BY ENGINE 5%
AUXILIARIES AND PIPING 13%	
BOILER LOSS (combustion and radiation) 24%	

FIG. 17.

If the present pumping station of the sewer system on the post were changed from engine to motor driven*, and motor-generator sets installed in the present power plant for supplying power to the fortifications, the average daily load would be increased at least 300 kilowatt-hours. The increase in operative cost (see Fig. 16) to produce this additional load would be \$3.00 per day, *or one cent per kilowatt-hour for such increased load*; and at the same time reduce the present operative cost per kilowatt-hour for the whole output from 2.5 to 2.2 cents. These changes would result in a saving to the government of \$2,400 per annum in the operation of the pumping station, and a saving of \$2,500 per annum in power for the fortifications (based on fortification power consumption for the fiscal year 1909, at 5 cents per kilowatt-hour now paid by the government).

* Now authorized by the Secretary of War.

From the data of operation, for the first three months, of the Coast Artillery School Power Plant, it is evident:

1. That the saving to the government by the operation of this plant has been more than sufficient to justify its installation.

2. That by the adoption of central station methods a marked decrease in cost of power and heat can be obtained at military posts where a power plant is in operation.

3. That the army can operate, with enlisted personnel, its own power plants, properly designed and installed, and produce light, heat and power as economically as a commercial plant of similar capacity and load factor.



APPENDIX "A"

BOILER ROOM LOG

Fort Monroe, Va.

190

[Note:—Boiler No. 1 only is shown in table. Similar columns are used for Nos. 2 and 3.]

TIME	BOILERS										PUMPS				HEATING				STEAM	
	No. 1										(Service*)				(Service*)				(Service*)	
	Coal Fed lb.	Water Used cu. ft.	Ash lb.	Gauge pressure lb.	Temp. Feed Water °F	Temp. in boiler °F	Per Cent CO ₂	Per Cent O ₂	Per Cent H ₂	Per Cent N ₂	Feed Water lb.	Dis. lb.	Dis. lb.	Dis. lb.	Dis. lb.	Dis. lb.	Dis. lb.	Dis. lb.		
Mid night																				
12:30																				
1:00																				
1:30																				
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11:00																				
11:30																				

SUPPLIES			
	1st Watch	2nd Watch	3d Watch
	to	to	to
COAL	On hand, tons		
Kind and size			
WOOD	On hand, cords		
CYLINDER OIL	Received		
On hand			
LUBRICATING OIL	Received		
On hand			
WASTE	Received		
On hand			
CLEANING MATERIAL	Received		
On hand			
REPAIRS REQUIRED			

SIGNATURES			
		Foreman, 1st Watch	
		Foreman, 2nd Watch	
		Foreman, 3d Watch	
EXAMINED			
		Master Electrician, C. A. C., in charge	
TOTAL SERVICE HOURS**			
Boiler	No. 1	No. 2	No. 3
Pumps	Feed No. 1	Feed No. 2	Hot water
Boiler	No.		
Heating Building	Exhaust	No.	Live Steam
Steam Pressure (Average)	Boiler No. 1	No. 2	No. 3
TOTAL CONSUMPTION**			
Coal Fired	No.		
Ash	No.		
Percent of Ash			
Water (cu. feet)	No.		
Average Temp. Feed Water	°F		
Oil	Cylinders	gals.	Lubricating
Waste	No.	Cleaning Material	gals.
Evaporation from end at 212 °F	No. per lb. coal		
Efficiency (Boiler & Grate)	No. 1	No. 2	No. 3
Boiler Factor			

* When boilers, pumps, heating system, etc., are "In Service" the letter S will be placed in this column; O when "Out of Service"; B when "Banked"; R when "Out of Repairs."

** Not to be filled in by fireman.

APPENDIX "B"

ENGINE ROOM LOG

Fort Monroe, Va.,

19

[Note:—Generator set No. 1 only is shown in table. Similar columns are used for Nos. 2 and 3.]

TIME	GENERATOR SET No. 1										Distribution										Customer		Starting System		Steam Pressure		Temp. °F		STORAGE BATTERY		WATER TOWER	
	SWITCHBOARD					LOADS					Power					Voltage	Current	In	Out	Pressure	Temp.	In	Temp.	Charging	Discharging	Total E.W.	Max. E.W.	E.W.				
	Engine		Generator		Bus	Main	Aux	E. W.	Total	E. W.	Total	E. W.	Total	E. W.																		
	Running	Stopped	Running	Stopped											Running														Stopped	Running	Stopped	Running
12:30																																
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SUPPLIES			
WATER	1	2	3
	to	to	to
CYLINDER OIL	Received		
	On hand		
LUBRICATING OIL	Received		
	On hand		
WASTE	Received		
	On hand		
CLEANING MATERIAL	Received		
	On hand		
REPAIRS REQUIRED			

EXAMINERS			
Engineer, in Charge			
Engineer, in Charge			
Engineer, in Charge			
EXAMINED			
Master Electrician, C. A. C., in Charge			
TOTAL SUPPLIES USED**			
Cylinder Oil	to	to	to
Lubricating Oil	to	to	to
TOTAL SUPPLIES OPERATED			
On hand	to	to	to
On hand	to	to	to
OUTPUT E. W. HOURS			
No. 1	No. 2	No. 3	
Lighting, Set			
"			
Power			
Total			
LOAD FACTOR			
No. 1	No. 2	No. 3	
Total			

* When "In Service" indicate letter S; "Out of Service" by O; "Out of Repairs" by R.

** Not to be filled in by Engineer.

*** To be recorded at beginning and end of each watch.

In charge of plant.

APPENDIX "C"

MONTHLY REPORT OF SUPPLIES

Fort Monroe, Va., ... 19.....

COAL:

On hand 1st day of month.....	lbs.	(@)	cts.
Received during month	lbs.	(@)	cts.
Total	lbs.	(@)	cts.
Consumed during month	lbs.	(@)	cts.
On hand last day of month.....	lbs.	(@)	cts.

WATER:

Meter reading last of m'th.....	cu. ft.
Meter reading 1st of m'th.....	cu. ft.
Consumed	cu. ft. (@) cts. per M

CYLINDER OIL:

On hand 1st day of month.....	gals.	(@)	cts.
Received during month	gals.	(@)	cts.
Total	gals.	(@)	cts.
Consumed during month	gals.	(@)	cts.
On hand last day of month.....	gals.	(@)	cts.

LUBRICATING OIL:

On hand 1st day of month.....	gals.	(@)	cts.
Received during month	gals.	(@)	cts.
Total	gals.	(@)	cts.
Consumed during month	gals.	(@)	cts.
On hand last day of month.....	gals.	(@)	cts.

COTTON WASTE:

On hand 1st day of month.....	lbs.	(@)	cts.
Received during month	lbs.	(@)	cts.
Total	lbs.	(@)	cts.
Consumed during month	lbs.	(@)	cts.
On hand last day of month.....	lbs.	(@)	cts.

PACKING:

On hand 1st day of month.....	lbs.	(@)	cts.
Received during month	lbs.	(@)	cts.
Total	lbs.	(@)	cts.
Consumed during month	lbs.	(@)	cts.
On hand last day of month.....	lbs.	(@)	cts.

CLEANING MATERIAL:

On hand 1st day of month.....	(@)	cts.
Received during month	(@)	cts.
Total	(@)	cts.
Consumed during month	(@)	cts.
On hand last day of month.....	(@)	cts.

In charge of supplies.

FIRE CONTROL SYSTEM FOR BATTERIES OF THE INTERMEDIATE ARMAMENT.*

BY CAPTAIN ARTHUR P. S. HYDE, COAST ARTILLERY CORPS.

On February 14, 1909, the writer wrote a letter setting forth the very unsatisfactory condition of affairs resulting from the assignment of two companies to a single battery at Fort Wetherill, R. I., (Varnum, two 12-inch guns) and recommended that Battery Zook, (three 6-inch guns) at the same post, be placed in commission so that one of the companies then at Varnum, could be assigned thereto.

Early in April, this letter was forwarded from the War Department to the District Engineer Officer in Newport, R. I., with instructions to proceed with such work as lay within his jurisdiction, necessary to place the battery in commission. The writer was shown this letter by the District Engineer Officer, and in order to expedite matters, wrote a letter dated April 20, 1909, requesting that the necessary fire control material based upon the standard equipment of a gun battery, be supplied. Following is the indorsement of the Acting Chief of Coast Artillery on this letter:—

4th Indorsement.

War Department,
Office of the Chief of Coast Artillery,

Washington, May 10, 1909.

1. Respectfully returned to the Chief of Ordnance, recommending the issue of one Warner & Swasey D.P.F. Type AII, understood to be on hand and available.

2. There are sufficient azimuth instruments in the Artillery District of Narragansett Bay to meet the necessary requirements of Battery Zook, and it is recommended that the District Commander make the necessary assignments.

3. The issue of a plotting board is not recommended at the present time. This battery is an important element of the intermediate armament of Fort Wetherill, and eventually it is the intention to recommend the issue to such batteries of range boards and wind component boards. At the

* Published upon the recommendation of the Chief of Coast Artillery, as an illustration of an improvised fire control system where the standard equipment is not on hand.

present time the commanding officer of the battery should improvise means for posting ranges and for making corrections in same based on observation of trial shots, these corrections to be applied in B' station before the ranges are transmitted to the emplacements for posting.

4. It is recommended that this communication be returned to the Commanding Officer, 130th Company, through military channels, for his information, and that he be directed to submit a requisition for the depression position finder required, on regular form.

(Signed) C. J. BAILEY,
Lieut.-Col., Coast Artillery Corps,
Acting Chief of Coast Artillery.

Acting upon the instructions contained in the above indorsement, a fire control system has been devised which not only works perfectly in drill and practice, but has the merit of being both simpler and quicker than the standard system for gun batteries.

The system consists essentially of a depression position finder, a time range board of special design with attachments for making range corrections based both on displacement and observation of fire, a simple and compact deflection table, a deflection board of special design, black boards at the emplacements for posting ranges, gun differences stencilled on the parapet, and an emergency depression position finder. Of these devices, only the depression position finder, azimuth instrument, extra telescopic sight Model of 1898 and three black boards were issued to the battery, all the other instruments having been constructed by members of the company, in accordance with the more or less gradual development of the system.

In the following text, the material as actually constructed and in use at Battery Zook will be described first, to be followed by the description of similar material, but properly constructed in a machine shop.

IMPROVED TIME-RANGE BOARD

(Fig. 1.)

This is based upon the well known idea advanced originally by Captain Henry J. Hatch, Coast Artillery Corps, and adopted and described in the JOURNAL OF THE UNITED STATES ARTILLERY for March-April, 1904, by Major William C. Davis, Coast Artillery Corp.

The board consists of a first quality close grained white pine board, free from knots, ten feet in length by one foot in width and two inches in thickness, mounted on a pair of trestles.

Along the left edge, an undercut slot one and a half inches wide and three quarters of an inch deep, has been channelled out,

to receive the gun arm. The strip along the left edge of the board, is also channelled out, $\frac{1}{4}$ inch wide on top, $\frac{1}{4}$ inch deep and $\frac{3}{4}$ inch wide on the bottom, to carry the guide of the T-square. The remainder of the board is covered with a single sheet of ten-to-the inch cross section paper, carefully glued to the surface. Plotting on the board is done to the rectangular co-ordinates of time and range. Time is measured across the board, the scale being one equal to ten seconds. Ranges are measured lengthwise of the board to the scale of one inch equal to one hundred yards.

Lengthwise of the board and three inches from its right edge, is ruled a heavy black line, which forms the origin from which all plotting is made and which is called the first plotting line. An inch and a half to the left of this, another black line is ruled lengthwise of the board, called the second plotting line. (Note: At Forts Adams and Wetherill, all the time interval bells are controlled by a single clock, hence all strike at the same interval of fifteen seconds. The standard fire control installation provides that each battery should have its own independent time interval system, and when this is provided, it will be possible to use a ten second time interval for batteries of the intermediate armament. In this case, the second plotting line should be one inch from the first.)

The board is graduated in ranges between the two plotting lines, every hundred yards being noted. To the left of the second plotting line is a third heavy line, broken in form, called the set forward line, at a distance from the second (to the time-scale of the board) of one observing interval plus the time of flight of the particular range.

This line is obviously a curve, but it was deemed advisable on the improvised board to make it a broken line, varying by a second at a time. Thus for ranges where the time varies from one and a half to two and a half seconds, the set-forward line is $1.5 + .2$ inches from the second plotting line, etc.

A long strip of oak, called the gun arm, slides in the groove at the left edge of the board. To the upper surface of this is glued a strip of cross section paper, graduated in ranges from 1000 yards to 10,600 yards, and in quadrant elevations for sub-caliber practice from 1200 to 2500 yards.

Near the right end of this arm on its under surface, is a rack, while a pinion meshing into it and operated by a small hand wheel, is secured in the board itself, below the gun arm. By turning the hand wheel, a longitudinal motion is given the gun arm.

An undercut groove 22 inches long by $\frac{13}{16}$ wide by $\frac{5}{16}$ deep,

is cut in the right end of the gun arm. In this moves a small slide bearing a double brass pointer, as shown on the drawing. This slide can be locked in any position by means of a cam locking device, operated by the handle shown. This is merely a horizontal brass disc, under the slide, and attached permanently to the shaft of the handle, with about $\frac{1}{16}$ inch eccentricity.

On the left edge of the board is the range correction scale, with 0 in the center, plus corrections to the left and minus corrections to the right. On the main board at the edge of the gun arm groove is the range difference scale. This has the 0 in the center, and exactly on a line with the 0 of the range correction scale and perpendicular to the plotting and set forward lines of the board. The range difference scale is graduated minus to the right and plus to the left.

At the right end of the main board is an arc of a circle graduated in degrees, the center graduation being the azimuth of the middle of the field of fire. Inside of this azimuth circle are marked the range differences for the displacement of the directing point of the battery from the primary station. At Battery Zook, the directing point is the B. C. station and the displacement is 163.82 yards. The azimuth is 307.93. The range differences are made to vary by ten yards.

The operation of the board is as follows:

Let us assume the following series of consecutive observations:

Azimuth	358.35	Range	9560
	359.44		9510
	360.53		9460
	2.02		9410

First set the gun arm, so that its 10,600 yard mark exactly corresponds with the 10,600 yard range line on the board, and the slide so that its double pointer reads 0 on both range difference and range correction scales.

The azimuth is required only for the purpose of obtaining the range difference, hence it need not be accurate beyond the nearest even degree. Therefore at the *first* bell, the reader calls 3-5-8. The assistant plotter, seated at the right end of the board, notes the corresponding range difference (—120) and moves the gun arm, by means of the hand wheel, until the pointer comes to —120 on the range difference scale. The effect is to pull back the gun arm 120 yards so that the 9560 yard range line of the board, coincides with the 9440 yard line of the gun arm. That is to say, the range difference has been applied directly on the gun arm.

At the third bell the reader calls out the range, 9-5-6-0. The

plotter sticks a pin at the intersection of the 9560 yard range line with the first plotting line, runs his eye across on the range line to the gun arm, or brings the T-square up to the pin, and calls the corresponding range, 9-4-4-0, to the guns. With this range the observer at the B. C. station obtains the angular travel of the target in the manner prescribed in the Drill Regulations.

At the next time interval the reader calls 3-5-9 at the first bell and 9-5-1-0 at the third. No change is necessary on the range difference scale. The plotter sticks a second pin at the intersection of the 9510 yard range line, places a straight edge against the two pins and sticks a third one at the intersection of the straight edge with the set forward line. He then moves the T-square till its edge comes in contact with the set-forward pin and calls the corresponding range on the gun arm, 9-2-6-0, to the guns. This is then the range to the set forward point of the target, corrected for displacement and travel during one predicting interval.

The plotter is now through with the first pin, so he pulls it up and immediately sticks it at the intersection of the first plotting line and the 9510 yard range line, *i.e.*, the last range called by the reader.

At the next time interval, the reader calls 2 at the first bell and 9-4-6-0 at the third.

The assistant plotter notes that the range difference is now —110 and moves the gun arm until the pointer comes opposite —110 on the range difference scale. This has the effect of adding 10 yards. The plotter pulls up the second pin and sticks it at the intersection of the second plotting line and the 9460 yard range line, brings his straight edge against the two pins, sticks the third pin at the intersection of the straight edge and the set forward line and calls the corresponding range, 9-2-1-0, as read on the gun arm, to the guns.

The plotting is continued indefinitely in a similar manner.

Should the time-range board not be in the same room as the position finder, as is now (April, 1910) the case at Battery Zook, the plotter is connected by telephone with the reader and an assistant, connected by telephone with the guns, operates the T-square and transmits the ranges to the guns. To avoid confusion, this assistant is called No. 1 and the assistant who applies range differences and range corrections, No. 2. The plotter works on the side of the board nearest the first plotting line, and both assistants on the side of the gun arm. Two benches, each the length of the board, are provided so that all three men may be seated.

With a ten second time interval, this method allows of sending a corrected range for the set-forward point, for each separate shot, 6-inch disappearing guns being capable of firing at the rate of six shots per minute. In fact as the entire operation of plotting requires only three seconds, the board is readily adaptable to five second intervals, and twelve corrected ranges per minute, making it suitable for all batteries of the intermediate and secondary armament.

With reference to the range correction device, its function is the application of an arbitrary range correction to the gun arm, independent of the range difference, and its method of operation is as follows:

The battery commander observes the fall of shot, and estimates the correction necessary to get on the target; or, at target practice, determines the average of the overs, or shorts, and telephones to the plotting room to apply this correction. Suppose it to be plus 130 yards. The assistant plotter moves the slide until the pointer reads 0 on the range correction scale, then moves the entire gun arm until the pointer reads 130. The effect is to add 130 yards to the range. *He then moves the slide back until its pointer reads the same on the range difference scale as it did before the arbitrary correction was applied.*

To guard against the possibility of forgetting the previous range difference, the assistant should keep a pin stuck in the board at the proper range difference.

PROPOSED TIME-RANGE BOARD

(Fig. 2.)

The board itself should be constructed similarly to the method followed in constructing the Whistler-Hearn Plotting Board, so as to compensate for expansion and contraction and prevent warping.

The principle underlying the proposed board is exactly the same as the improvised board, the chief difference being the substitution of metal scales for paper ones.

As shown in the drawing, the first and second plotting lines are engraved on separate strips of metal. These strips are adjustable. As shown they are arranged for a 15-second observing interval. Should the observing interval be ten seconds, five seconds will be gained between observations and five seconds more on the prediction, hence the time between the first observation and the fall of projectile will be ten seconds less than with the 15-second interval. Therefore the second plotting line must

be one-half inch (five seconds) and the first plotting line one inch (ten seconds) nearer the set-forward line.

To accomplish this, remove the screws from the strips bearing the plotting lines and graduations, and move the strips toward the set-forward line the required amounts, and then put the screws in again. The two strips will then be in contact with each other and as near the set-forward line as the construction of the board allows.

The metal plates are pierced at every tenth of an inch along each of the plotting and set-forward lines, to provide for the insertion of the pins. Ordinary large headed pins about two inches in length should be used, as pegs of any kind would be of too great diameter for accurate work.

RANGE DIFFERENCE CHART

(Figs. 1 and 2.)

The range difference chart consists of an arc of a circle graduated in degrees. A blank strip of zinc or other suitable material is placed outside of the azimuth circle and a similar one inside of it. On these strips should be stamped, or otherwise marked, the azimuths and corresponding range differences for the particular battery at which the board is to be used.

A small hole is provided in the azimuth circle at each degree, in which a peg fits so that the assistant plotter may record continuously the changing azimuth of the target.

DEFLECTION TABLE

(Fig. 3.)

This is a board, shaped with a handle, the rectangular portion being 3 x 6 inches. On one side of this is attached a table giving the time of flight in seconds and fifths of a second, the drift in hundredths of a degree, and the deviation due to a ten-mile cross-wind in hundredths of a degree for each two hundred yards of range from 1000 to 10,000 yards, for service ammunition. On the other side is attached a similar table for 1-pounder sub-caliber ammunition, for every fifty yards of range between 1000 and 3500 yards. Both tables are covered and protected by sheets of mica neatly framed on.

IMPROVED DEFLECTION BOARD

(Fig. 4.)

This is a device for obtaining the algebraic sum of the deflection corrections due to travel, drift and wind. It consists of an oak board 24 x 5 inches in size, channelled out to hold three movable slides.

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The slides are so constructed that a movement of the lowest one carries both the others with it, a movement of the second one

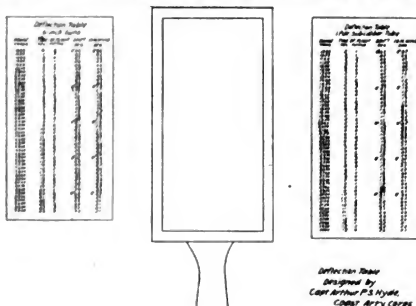


FIG. 3.

carries the top one with it, while a movement of the top one only, is independent of the others. At each end of each slide is a small brass button handle for convenience in moving it.

Deflection Board
for Sight of
Intermediate and Secondary
Armament
Designed by
Capt Arthur P.S. Hyde
Coast Artillery Corps

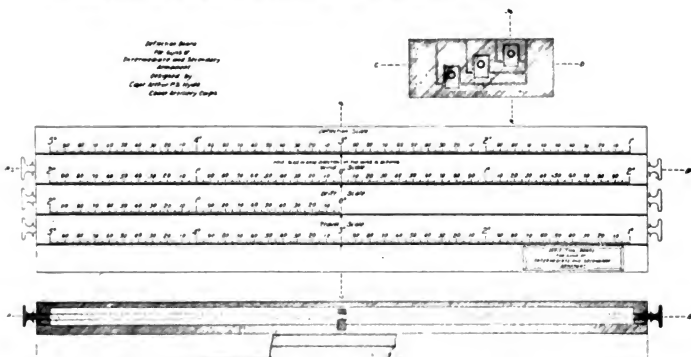


FIG. 4.

On the upper part of the board at the edge of the top movable slide, is the deflection scale, graduated in the same manner as the deflection scale on the sight, i.e., from right to left with the "3" in the middle. On the lower part, on the edge of the lowest slide, is a fixed pointer, or index, directly opposite the "3" of the deflection scale.

The lowest slide is graduated in the same manner as the deflection scale, and the scale thus formed is called the travel scale. The middle slide carries the drift scale and is graduated only to the left of the center, the center being marked "0". The top slide carries the wind scale. The degrees are numbered to the right and left from the middle or "0" of the scale. This scale bears the legend "Move slide in same direction as wind is blowing." Each slide has a pointer or index, opposite its middle. All scales are constructed to the scale of 5 inches to the degree with a least reading of .01 of a degree.

The deflection board is used at the B.C. station. To operate it proceed as follows:—

Assume the first range from the primary station corrected for displacement to be 2450 yards and the cross wind to be 5 miles per hour *from* the right. The operator takes from the deflection table, the time of flight corresponding to the nearest tabular range, in this case, 2400 yards, or $3\frac{3}{5}$ seconds.

The observer then measures the angular travel of the target during $3\frac{3}{5}$ seconds, the deflection board operator starting a stop watch when the observer says "now" and calling "halt" at the expiration of $3\frac{3}{5}$ seconds. Assume the reading of the deflection scale of the observing instrument, representing this travel, to be 2.85. The operator sets the travel slide of the deflection board so that the 2.85 division of its scale coincides with the fixed pointer. He then sets the drift slide so that the .06 division (the drift for 2400 yards taken from the deflection table) coincides with the pointer of the travel scale. This has the effect of combining the drift correction with that for travel. He then moves the wind scale to the left until the .04 division (one-half the correction for a 10-mile wind for 2400 yards, from the deflection table) coincides with the pointer of the drift scale. This has the effect of combining the wind correction with those for drift and travel. The coincidence of the wind scale pointer with a division on the fixed deflection scale, then gives the deflection, 3.13.

This deflection is called by megaphone to the guns. It is only necessary to compute the deflection for the first shot of a series, the gun pointers thereafter correcting their deflection by observation of fire.

PROPOSED DEFLECTION BOARD

(Fig. 4.)

The principle of this is exactly the same as the home-made board differing only in mechanical details. In the proposed



Photograph by Engineer W. H. Nutt, C. A. C.

FIG. 5. PARAPET SHOWING GUN DIFFERENCES AND BLACKBOARD.



Photograph by Engineer W. H. Nutt, C. A. C.

FIG. 6. GUN DIFFERENCES AS SEEN BY THE RANGE SETTER.

board the scales are all metal. Under the travel slide is a nut attached perpendicularly to the bed of the board, at its middle point from end to end. Through this operates a shaft with a screw thread cut on it, attached to the under side of the slide, but free to turn in the nut. A knurled head on each end of this shaft facilitates the operation. Similar nuts and shafts are provided for each of the other slides, as shown in the drawing. A turning movement of the travel slide shaft causes all the slides to move; a turning movement of the drift slide shaft causes the wind and drift slides to move; and a turning movement of the wind slide shaft, causes that slide only to move.

The operation is exactly similar to that of the improvised board.

BLACKBOARDS

(Fig. 5.)

An attempt was made to have the range setter connected directly with the plotter, by telephone, as is prescribed in the Drill Regulations; but on account of the small size of the 6-inch carriage, and the consequent close proximity of the range setter to the breech, the noise made in loading is so great as to interfere materially with his hearing. It has therefore been necessary to provide an additional man, No. 10, as telephone operator, in each gun section. He not only calls the ranges as received from the plotting room, but posts them on a black board attached to the parapet, beside the telephone and in plain view of the range setter.

GUN DIFFERENCES

(Figs. 5 and 6.)

A black band eight inches wide at about the height of the eye, has been painted on the parapet in front of each gun. A white line is stencilled vertically across this band at every azimuth where the gun difference changes by 10 yards, and the amount of the gun difference is stencilled in figures three inches high with the correct sign, plus or minus, between these lines. If the arc of fire for a given gun difference be relatively great, the figures are repeated at intervals of about two feet. The azimuths of the lines separating different gun differences are also stencilled in small figures—this merely for checking purposes.

The range setter standing at his post, has his vision to the front limited by the chassis on the right, and the sight standard on the left. He can therefore see but a small part of the black band and white figures. The latter have been so arranged that

as he looks to the front, the figures representing the gun difference that appear just to the right of the right edge of the sight standard, are the correction to be applied to the posted range.

EMERGENCY DEPRESSION POSITION FINDER

(Figs. 7 and 8.)

It is highly desirable that the battery commander be provided with an observing instrument having a movable vertical wire and a deflection scale. Without such an instrument it is impossible to determine with any degree of accuracy what arbitrary correction based upon observation of fire, is to be applied on the deflection board, for batteries equipped with the standard fire control system for either guns or mortars.

Under the system of fire control above described, while it is possible for each gun pointer independently to measure the travel and combine it with wind and drift corrections, it has been

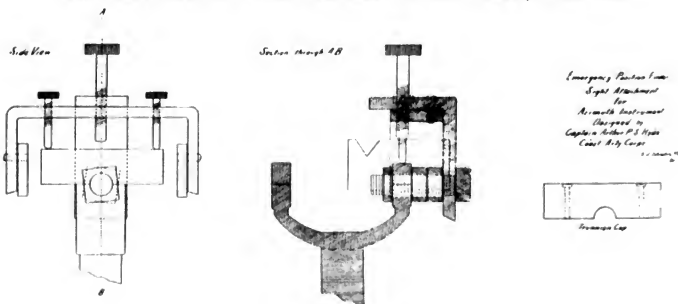


FIG. 7.

found in practice to be much better to determine the initial deflection at one place for the entire battery. It is therefore essential that the battery commander's instrument should meet the requirements of the case.

A Hagood mount was first used but it was found that its screw thread differed from that of the pier mount provided for an azimuth instrument. Besides, the traversing device of the Hagood mount is not well adapted to the purpose required.

Carrying out the idea previously suggested by Captain John C. Ohnstad, Coast Artillery Corps, a Model of 1898 sight was substituted for the telescope on a Warner and Swasey azimuth instrument, Model of 1900.

To accomplish this a sight bracket was made, provided with



Photograph by Engineer W. H. Nutt, C. A. C.

FIG. 8. EMERGENCY DEPRESSION POSITION FINDER DESIGNED BY CAPTAIN ARTHUR P. S. HYDE, COAST ARTILLERY CORPS.



Photograph by Engineer W. H. Nutt, C. A. C.

**THE BATTERY COMMANDER'S STATION, BATTERY ZOOK, FORT WETHERILL,
R. I. EMERGENCY DEPRESSION POSITION FINDER ON THE PARAPET,
AND DEFLECTION BOARD IN FOREGROUND ON THE RIGHT SIDE.**

a $\frac{1}{8}$ -inch bolt at right angles with the telescope and under it. The telescope of the azimuth instrument is then removed and the cap-square screwed on the left side of the yoke.* The bolt of the sight bracket is then passed through between the trunnion bed and cap-square, from left to right and clamped firmly in place by a nut. The telescope of the sight placed on the bracket, is then just above where the telescope of the azimuth instrument should be.

The bubble of the cross level is brought to the center by the leveling screw of the sight bracket. A slow motion screw device, consisting of two screws bearing on the top of the cap square, is introduced on the bracket to bring the bubble of the telescope level to the center when the vertical arc reads "0".

An instrument is thus provided that not only answers the requirements with respect to deflections, but also one that is capable of measuring angles of depression.

At battery Zook the height of the instrument with telescope level, above mean low water is 87.2 feet and the mean rise of tide is 3.9 feet. The height above the mean stage of the tide is therefore 85.25 feet. Taking this as the length of the vertical base, a table has been calculated showing the range corresponding to each minute of depression. So much of this table as applies to sub-caliber ranges, follows:

Angle °	Range Yds.	Angle °	Range Yds.	Angle °	Range Yds.	Angle °	Range Yds.
1 21	1205	1 10	1395	0 59	1655	0 48	2034
20	1220	9	1415	58	1683	47	2077
19	1236	8	1436	57	1713	46	2122
18	1252	7	1457	56	1743	45	2170
17	1268	6	1479	55	1775	44	2219
16	1284	5	1502	54	1808	43	2270
15	1302	4	1525	53	1842	42	2325
14	1319	3	1550	52	1877	41	2381
13	1337	2	1575	51	1914	40	2441
12	1356	1	1600	50	1953	39	2503
11	1375	0	1627	49	1992	38	2570

While it is appreciated that the lack of correction devices for height of tide and refraction, make these ranges incorrect, yet it is maintained as the result of practical use at sub-caliber and service practice, that it answers admirably as an *emergency* instrument, the ranges determined being closely approximate to the true ones and far better than an estimation by the eye only. It is of especial advantage in determining *relative* ranges as between the splash and the target.

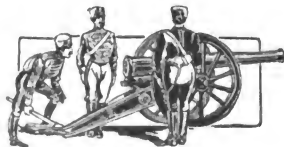
* This has been modified by providing a bolt long enough to rest in both trunnion beds, held in place by a clamp nut on the outside, and by the cap-squares.

REMARKS

This system of fire control, especially the time-range board, is dependent upon the plotting of ranges and not azimuths, and therefore is primarily adapted to the use either of the depression position finder, or a self-contained horizontal base instrument. I am of the opinion, however, that Captain Charles E. Kilbourne, Coast Artillery Corps, has constructed a device on the principle of the slide rule for the rapid conversion of azimuths into ranges. In other words for the solution of the oblique triangle formed by the primary and secondary stations and the target, obtaining the range from B'. Such a device is all that is necessary to adapt this system to the horizontal base.

In developing this system much credit for practical suggestions is due to the following:—1st Lieutenant Charles E. Wheatley, Coast Artillery Corps, 1st Sergeant Walter Rector, Sergeant David J. Ketchum and Private Lars L. Wenaas, 130th Company, Coast Artillery Corps.

Credit is also due to the following for the practical work involved in the construction of the devices in use at Battery Zook: To Sergeant Arthur A. Vannarsdale, Corporal Joshua H. Bell and Mechanic George Zaher, 130th Company, Coast Artillery Corps, for carpenter work; to Private Mack G. O'Brien, 130th Company, Coast Artillery Corps, for blacksmith work. Also to Major Clarence H. Greene, Corps of Engineers, R. I. N. G., for furnishing the rack, pinion and hand wheel for the gun arm and the slide with its cam locking device, for the time-range board, which it was impracticable to construct at the post.



MILITARY EDUCATION OF OFFICERS IN TIME OF PEACE

LECTURE BY MAJOR EBEN SWIFT, GENERAL STAFF, APRIL 1, 1910

Although war has been the favorite occupation of mankind for some thousands of years, its development has not been rapid. New ideas seem to have been more slow to dawn upon the human mind in this than in other fields of thought and action. To-day our scientists are digging in the sands of Asia to find relics of civilizations which grew, rotted and died before mankind ever saw a well-drilled battalion of soldiers. Great areas of the earth's surface have often been plundered by conquering nations who never mastered the simplest principles of outposts, or of advance, rear and flank guards. Such simple expedients as the surprise, the ambush, the flank attack, the reinforced center, fooled and bewildered the best soldiers of early days, but these and other deeper principles of strategy and tactics you will see to-day practiced by school boys in a game of football. Before the art of commanding men had developed the field order, the telegraph and the steam engine had become commonplace elements of our civilization. This slowness, however, is now disappearing and in recent years the art of war has made great strides and has been able to call many other arts and sciences to its assistance. And now the title to command men must be proved by knowledge and not by personal example. The leader who ruled by the right of might is now replaced by a graduate of a military university. Formerly soldiers were urged to great deeds by the hope of loot in this world and a luxurious heaven in the next; now their minds are bound by the claims of duty and patriotism.

In all human progress the most potent factor has been the school, in which the accumulated wisdom of the ages is spread and disseminated. For centuries the time-honored method of the school has been by the class recitation or periodical examination, or by the two combined, based on text-books which are adopted as a standard. The test of efficiency was the ability to answer questions taken from the books. Against this system is the fact that a series of perfect recitations may be followed by a deficient examination. A proficient examination may be fol-

lowed in a short time by a deficient examination. It is also to be objected that such a system may develop the memory at the expense of other qualities that need improvement just as much or more. It occupies a large part of our West Point course, our examinations for promotion and our post school system. I believe that in the art of war, this system, unless closely watched, develops pedantry instead of real knowledge. If it is the best in scientific branches of the profession it is harmful in strategy and tactics. Whenever we attempt to theorize on the art of war we find that every rule, as Wagner says, "is subject to a multitude of exceptions," and we never know whether to apply the rule or the exception.

Another system of learning, greatly favored by soldiers of every age, and for centuries accepted as the only one by which soldiers could learn their profession, may be called the School of Experience—meaning, by experience, actual experience in war. It arises from the fallacious idea that war can only be taught by war itself. It was good enough when wars were frequent, armies small and knowledge an unnecessary asset for leaders. The faults and dangers of the School of Experience are shown strongly in our own experience. Our Civil War cost five billion dollars and killed off the best of the race. As a guide for national education the lesson of it is that it was too slow to give us hope for any efficient scheme of national defense. Starting with everything to learn, the armies for more than a year showed every fault of raw troops. They straggled by tens of thousands after a year and a half. They never entirely lost the tendency to panic and route. They deserted by hundreds of thousands. In fact we have, as Napier says, "Sought in blood the knowledge necessary for success." The increased efficiency of the world in military matters calls for quicker work now and that is the least that can be said.

In all that pertained to the duties of high command the leaders of that day began without experience, instruction or precedent to guide them. Many excellent men were given great responsibilities at the beginning and were ruined before they had a fair chance. The most fortunate did not avoid great blunders, but finally learned by their own experiences and the mistakes of others.

Other professions than ours have been much quicker in seeing this difficulty and in finding a remedy. That was because practice is their daily life, while wars are separated by many years. The schools of medicine, electricity, law, engineering and others, of late years have constantly improved and developed

the practical course. They have reached the point where theory and practice go hand in hand, teaching principles by practical examples, and sending out graduates ready to begin the active practice of their profession.

But, because the nature of war was not understood, it was long before the same result was accomplished by military men. During long periods of peace armies lost their practical character; complicated maneuvers were introduced and retained after improvements in weapons had rendered them useless. To keep these soldiers busy they were taught to fire a gun in 200 motions, they learned the parade step and many evolutions. To march through a village they climbed over the roofs of the houses. Armies were saturated with training that was beautiful in peace, but worthless in war.

THE APPLICATORY SYSTEM

Every war has brushed away many of these excrescences of peace, with more or less success, but it is only lately that the soldier's life in peace has been intelligently ordered so as to prepare him for war.

Some monumental disasters to such peace-trained armies induced soldiers to seek methods that would supply them with some of the practice and experience that they would need in war. The adoption of a suitable system was of slow growth and was the product of many independent lines of thought. It may now be logically arranged into a beautiful system which may be called the applicatory or deductive system. It is now the most complete, logical and systematic of all practical courses as it ought to be, because in war the theory is less exact, the rules more elastic than in other sciences. In fact, although we may prescribe rules in some sciences and arts, it is safer in war to consider each case as an exception to the rule—to be studied by itself.

The first great principle that was discovered was that most of the situations requiring practical knowledge by officers could be considered entirely apart from the battle itself and even from the presence of troops.

When we have accepted this fact we may proceed to a second principle, namely that one thing should be taught at a time, in logical order, following the sequence of events as they would present themselves in actual service.

The third principle is that by a proper selection of examples for study an officer will be able to acquire a variety of experience closely resembling that obtained in a real campaign.

We at once encounter our greatest difficulty, which, as in every other practical system, consists in finding time for the consideration of a sufficient number of illustrations. In this point this method partially resembles the second, where knowledge is gained by actual experience only—the greater the number of experiences the greater the knowledge gained. We must acknowledge of course that we never learn this any more than any other profession. The study of examples and the collection of useful experience must continue as long as we are on the active list.

It will soon be apparent that our new system has some decided advantages over the actual school of war. In war the ground, the troops, the killed and wounded, conflicting reports, the sense of responsibility, the nervous strain are all crowded upon us at once with a thousand variations. In our peace system we exclude every influence and every subject except the one proper to the case in hand.

All there is to the applicatory system is the study of concrete cases instead of the abstract study of principles. The principle and the illustration may be considered together, but it is better to study the example first and decide on the principle afterwards. It is like the method of the child in learning to speak the language before learning the grammar, for here we study the campaign first and pick out the principles afterwards, thus reversing the former methods.

Taking account only of the duties of officers, we may divide them into two classes—those conducted indoors and those conducted in the open. In the first class are map problems and map maneuvers; in the second class are staff rides or terrain exercises and maneuvers. I will discuss them in the order named.

I. INDOOR EXERCISES

A. *Map Problems.*—Starting out on the broad principle that education consists in thoroughly learning one thing at a time, we place map problems at the head of the practical course. The map problem is simply a military problem, admitting of a written answer solved by the aid of a map. The questions are such as require a study of the map and, under the usual conditions of service, would be solved by the commanding officer and his staff. It is natural that the map should call for our first attention because we ordinarily see it before we have a chance to examine the ground which it represents. An early experience is thus obtained of the difficulties which are encountered at the beginning

of every military operation. It is better than the corresponding experience in active service because you have nothing to divert you, plenty of time to make up your mind, and full opportunity to discuss and criticise. It is supposed that training of this kind develops the judgment in such a way as to lead to prompt and rapid decisions. The mind is led into the same channels which it would follow in active service; in peace you study long over some order that would perhaps be given verbally and without preparation but when the day of action comes men will say that you are filled with quick and happy inspirations in the field. A great soldier has left on record the statement that it was not genius that revealed to him the sudden and unerring solutions of military problems that often astonished the world—it was long study. "I brood upon the map," he said. The study of the map, then, helps us to give the proper direction of events, and to formulate definite plans of action. In other words, it is a study of orders.

The entire fabric of the art of command rests on the order. It is not enough that a leader be self-reliant and experienced; his subordinates loyal and skillful; his troops well disciplined and filled with enthusiasm. All these, Napoleon, for instance, had, but his best plans often failed or came near disaster. He excelled in clear and vigorous language, but he lacked the precision and system that we supply in the modern order.

We are familiar enough with one class of orders—that is, the commands of the drill book, but they form a very small part of the orders that an officer has to issue in a campaign. When we observe how long it takes the average officer to issue some small directions of ordinary peace routine, we are apt to wonder how long it would take him to issue an order to a patrol for reconnoitering a village or for some other simple bit of field work.

The tendency to give a multiplicity of aimless instructions in all orders caused the adoption of a uniform system, so that nothing shall be forgotten and at the same time to insure that enough be prescribed. To learn this system will take much study and practice before a habit of command can be acquired and we should be satisfied with nothing less.

The order is not necessarily issued in writing or to a large command. We should use just the same principles in a verbal order to a small command. General Emory Upton used to say that an officer who was competent to drill one man was able to drill a brigade. Well, a man who can issue a proper order to a patrol is fit to give one to a brigade.

B. Map Maneuvers.—One step further than the map problem is the map maneuver. It is a development of the ancient game of chess which was one of the earliest efforts to give a military character to games of chance. In the map maneuver we use a map on a large scale instead of a checker-board, for pawns we use blocks or markers indicating tactical organizations, and for moves and rules we are governed by the well-known powers and limitations of troops under varying conditions.

It supplies an idea of the moving incidents of the campaign and those matters which depend upon the factors of time and space, and the various relations between the troops and the ground, such as the ployment and deployment of lines and columns, rates of march, the capacities of defensive and offensive positions to commands of a certain size. Having, therefore, filled the mind with some military situation; having formed your plan, issued your orders, and made your dispositions, the whole may be tested by map maneuvers.

The original idea of map maneuvers and, in fact, the leading idea of every practice of this kind, up to a recent date, was really to make it a game, although it was called a "battle exercise," in which decisions were given as to the actual loss in killed and wounded, the effect of fatigue and demoralization, and the influences of chance on the final result; in fact, all modifying factors that could be thought of were duly considered. It made an exceedingly complicated system, requiring much study and practice. Its many difficulties limited its use to a few localities where there were exceptional advantages in its favor. Recent improvements in weapons of war and important changes in methods of attack and defense have caused doubt to be felt as to the accuracy of former rules under the latest conditions, and gradually the battle and game idea has become eliminated from the exercise. This simplifies it greatly and leads to its logical use as an aid to instruction. It is used as an exercise simply in maneuvering troops up to the moment of actual contact. Prior to this the small combats of minor importance are settled in a general way by the decision of the umpire. As soon as the plans of both sides are developed and there only remains the final test of battle to decide the result, the umpire discusses the final situation.

The two-sided exercise has some disadvantages due to the tendency to the game idea. We have been quite well pleased with the results obtained by a different form of the exercise in which the director himself is pitted against the balance of the party. The blocks representing troops are dispensed with.

Ground-glass plates or transparent sheets of celluloid are placed over the map and the changing positions of troops are marked upon them by colored pencils. This avoids a number of the troublesome features of the other exercise and makes it possible to keep an excellent permanent record of its progress. Its principal value is in eliminating entirely the game idea. The director is able in this exercise to lead it in any direction he chooses and to make it a lesson in some interesting point of tactics or strategy, or both.

The map maneuver is generally an obligatory part of the military education of officers, and in its simpler forms it is used for the indoor instruction of noncommissioned officers and men. Its principal advantages are:

1. It supplements previous exercises by practice in map reading.
2. It has the advantage of presenting the whole situation and not a portion of it to the view.
3. It gives practice in issuing, interpreting and executing orders.
4. It gives practice in showing the principles and application of strategy and tactics. In the same way it is a useful adjunct to the study of military history.
5. It gives practice in making quick and accurate decisions. In the application of principles it shows in a few hours operations that would ordinarily consume many days.

II. OUTDOOR EXERCISES

A. *War Rides*.—The next form of exercise has been called war ride, staff ride, terrain exercise, and so on. The troops are still imaginary, but the map is replaced by the real ground. The officers work out their problems in the open. In this way they come to understand the relations between the ground and the map; they see the limitations that exist in the picture of ground given by the very best map, and they verify the principle, that while general directions are given from the map, the details must be left to the commander on the ground. The troops remain imaginary, because the idea is still to develop and persistently to cultivate in the officers a perception of the capabilities of the ground itself, a quality which is all-important and exceedingly rare. It means an ability to grasp the military features of a landscape, just by looking at it, to conceal your own designs and to discover those of the enemy from slight indications, to make proper dispositions for emergency, to select an objective and not

to lose it. It is evident that the tendency would be to devote one's self to the personal direction of the troops if they were present, and to forget many of the details necessary for an officer at this time to attend to.

The exercise may be conducted under a dozen or more forms. In all of them the object is to visit some piece of country where the various conditions of military study are imagined just as if the landscape were full of troops. For instance, a detail of officers could ride out and select ground for future battles in the neighborhood, just as German staff officers are said to have done in France before the War of 1870, and just as we know that the Confederate General Johnston did before he retreated on Atlanta in 1864. On a smaller scale we might indicate how we could defend a village, attack a wood, cross a river, ascend a height, or search a country for another force.

B. Maneuvers.—At last we bring the troops themselves into our exercises. The officers having pursued their studies in every matter requiring judgment and thought, it is time to take up the mechanical handling of the men. By this time the officers have learned to judge country and to maneuver properly over any kind of terrain. They have acquired an easy self-confidence for the ready assumption of command which replaces the vacillation, hesitation, contradictions, empty repetitions and undue reliance upon the advice of subordinates that characterise the man who had so far never tested himself.

It is better to conduct maneuvers through several stages. At the first the enemy need not be represented, but merely outlined, or indicated by flags or markers.

The officer can now give his principal thought to the powers and limitations of the troops themselves. It will require his best efforts to conduct them so as to get into contact with the enemy with a minimum amount of fatigue. We will soon see that the energy of troops is so greatly reduced by fatigue that it is a more disorganizing element even than the bullets of the enemy.

Then the fire action is introduced by adding the opposing fire and blank cartridges are used. This is the last rehearsal in time of peace for the serious act of war. The applicatory system of instruction, teaching one thing at a time, throwing no man into deep water before he knows how to swim, has carried us to the final stage where both troops and leaders are called on to show all that they know. One has learned to command and both have learned to obey. Every effort must now be made to make the drill merely a bloodless battle, in order that the battle may be only a

bloody repetition of the daily drill. In most respects we may claim that we have given a practical demonstration of war, lacking the final test which we can not supply in peace. In this we are still at a disadvantage with other professions, but we have narrowed the chasm between practice and theory until it is almost a step across.

In an ideal application of this progressive series of exercises we would start the yearly course at the beginning of winter with simple map problems involving the issue of orders for operations on familiar terrain near the post. As many of these situations should be studied as convenient during half of the winter sessions. This should be followed by the practical working of the same or similar problems as map maneuvers. At the beginning of spring the officers should go out in the open for a further test and application on the ground itself. Later the troops would enter at the final exercises.

C. The Study of Military History.—If we accept the idea that the principal aim of our military education is to collect individual experience we will at once be struck with the importance of turning first to the experience of others before we consider our own.

The abstract study of history is interesting in the first place, but it has the additional value to us of furnishing a live example upon which to work. The more intimate our knowledge of the historical case the more able we are to see ourselves in the same conditions, the less do we tax our imaginations, and the clearer do we see the way to apply ourselves to the solution of the problem by the means we use to-day. Not only is this the case in the study of strategy of past campaigns, but also in tactics. In any campaign we can begin by solving the problem that the commander of the troops and his staff solved, we can issue the orders as we would issue them to-day, and we can solve in sequence each of the tactical situations that come up.

This is in exact accordance with the advice of Napoleon who said, "If you want to learn the art of war, study attentively the campaigns of the great masters." The trouble with most people is that they have not studied attentively and understandingly these campaigns, and that they often attempt to deduce doctrines and theories to be followed. If Napoleon had elaborated his idea he probably would have added these words:—"and meditate upon your proper action under the circumstances with the arms, material and conditions of your own day."

Thus the pages of history open an inexhaustible field for

investigation. In the schools we merely make a beginning and trust to the students to add to their experience every day they live. For every experience is different from every other, and every case is an exception to a rule.

The historical example removes a great difficulty that we find in the selection of examples. A fictitious or hypothetical situation requires a great effort of the imagination and does not arouse the interest that the historical case gives us.

Particularly valuable is the study of our own history because it leads us to form our own theory of the art of war, based upon our own experience and limited by our own resources. It enables us better to appreciate our own difficulties and to provide for meeting them in case of emergency.

In this way we find ourselves in the place of competent critics of great events. The formation of independent decisions upon historical events builds up the self reliance of officers and sooner or later forms a habit of dealing with great questions with firmness and confidence.

D. The Oral System.—The advantages of an oral system of education over the old text-book system are that it affords opportunity for elaboration, explanation and interchange of ideas. The statements of the text-book seldom arouse the student's interest or enlist his enthusiasm, call for no original effort, and do not develop self-confidence and quick decision, so necessary in a course of practical education.

A discussion of oral methods would carry us back to the time when this was the earliest and only means of instruction. It has been partially lost from sight since books have become so easy to obtain, but we must not fail to note its value. We often see well educated and well informed men who never read a book, but whose entire stock of information is obtained by observation, listening, and by contact with the world. I will ask special attention to only two points. First, as to its value in the study of military history by illustrated lectures; second, in the value of the Conference as an aid to instruction.

The amount of time saved by a lecture course in military history is hard to calculate. Nothing is more difficult than study of a modern campaign. It takes weeks and months of study, much of the time being wasted in trivialities, hunting for places on the map, etc. But a lecturer with a stereopticon and an abundant supply of maps on lantern slides can give it all in a few hours. He gives the class the benefit of his long studies instead of requiring the same amount of labor from each member of the class

that he himself has given. I believe the graphic representation of events gives a better mental picture, is quicker, more illuminating, is remembered longer than the tediously studied narrative. The same principle holds good for many other branches of military investigation.

Equally important is the conference system. All through the applicatory course of instruction, in every map problem, map maneuver, staff ride, tactical ride, the class is gathered together for the discussion of all completed work.

An instructor acting as leader or moderator opens the discussion and submits an approved solution after having read and studied all the solutions submitted. His solution may be either a composite of the best points of all, or his own single idea, or a solution of one of the class. Usually the composite solution is taken.

We know that discussions often become irksome, degenerate into personal argument, and waste much time, unless carefully conducted. I believe this is because of the natural tendency to adverse comment and destructive criticism. It has been found that little is gained by telling a man of his errors, which often arouses his combative instinct, while he will usually discover his errors and acknowledge them to himself if left alone. A different condition of mind possesses the meeting if we ignore the wrong and uphold the right. It is also more logical, for the prime object of instruction of the whole class should not be forgotten in undue attention to individuals. Experience shows that a majority of officers who have carefully studied a subject will give a good solution. A majority of this majority will give a very good one, a minority will give a solution of doubtful value, and a small minority of the minority will give odd or unusual solutions. The instructor endeavors to present a correct solution which, as I say, usually accords with the best sentiment of the class, and this practice continued through a great many sessions gradually develops a consistent line of thought. We rather fail in our mission unless we are able to state our decisions and principles in such a way as to appeal to the good judgment of the entire class, and it is entirely useless to try to teach things that men do not believe.

Under such a system the individuals of the class become instrumentalities in assisting the instructor to instruct the entire class. It is a great and useful aid. Upon the skill with which the instructor takes advantage of this psychological condition the success of the oral system largely depends. The tendency

will be to get together. Each man will want to stand with the majority and he is still better pleased when he belongs to the majority of the majority. The odd man will feel his isolation and he will be gratified when he finds he is with them. The man who is generally odd is usually wrong.

Over the entire course of instruction there should be one general dominating principle and that is that safe leaders are desired for our troops—not brilliant or erratic leaders. Methods of the latter are risky, rely too much upon the manner of execution, do not give credit to the efficiency of the enemy, are easily frustrated by modern defensive means, rely on chance.

Acceptance of this principle at the beginning enables us to build up a consistent and reasonable school of thought on military questions which would insure team work of a high order by the same class of officers in time of war. It would secure the proper appreciation of the relations of separate commanders to each other and of the commander to his staff instead of the cross purposes and lack of cooperation so often seen. Only by broadening the system of instruction do we stand a chance of remedying the most serious defects of armies. The independent critical habit, whereby no two men think alike, makes jealousy and discord the greatest curse to an army.

E. Results.—There is nothing easy about these new methods. They are of little value unless accompanied by hard work and applied with enthusiasm. They are fit only for really fine soldiers. They fail in the hands of troops who do their duty without energy and in a perfunctory way. But when well done no labor ever had a greater reward, no result is ever more startling.

It is well settled that the wars of the future will be conducted by peace-trained soldiers, commanded by peace-trained generals, assisted by a peace-trained staff. They take the field with as much serenity and confidence as if they were veterans of a hundred battles. And, strange as it may seem, they carry on war far more efficiently than any other set of men who ever lived. Someone has called it a "barrack begotten art of war." That is what it is. It places mediocrity above genius, it gives control to men who do nothing brilliant, but who make no mistakes, and it deeply buries much of the romance that clings about our profession. But it is the modern development of war.

COAST ARTILLERY RESERVES

BY MAJOR W. G. HAAN, COAST ARTILLERY CORPS

In 1902 Secretary of War Elihu Root said: "One of the most valuable services which can be rendered to the country by its militia is to supplement the regular force in manning the coast defenses in time of war. Our present regular force is none too large to take care of the guns and the machinery of the fortifications in time of peace. It will be quite insufficient in war. * * *

"Manning the coast fortifications is constitutional militia work, for it is always to repel invasion. It can be undertaken by citizens living in the neighborhood of the fortifications with less disturbance and sacrifice than any other military duty, because it does not take them far away from their homes and business. The handling of the modern high-power and rapid-fire guns and the complicated machinery by which they are worked requires, it is true, special training, but there is no trouble in securing a reasonable degree of that for heavy artillery militia organizations.

* * * * *

"An effort should be made to procure the organization of a National Guard force of heavy artillerymen in the neighborhood of each coast-defense fortification, with the understanding that whenever the President finds occasion to call out militia to repel invasion that organization will be called into that fortification. In the meantime an immediate and special relation should be established between the militia organization and the fortification for the purpose of practice and instruction. They should be made as familiar as possible with the use of the guns and methods of defense at that particular point. In many cases it will be practicable to give them facilities for meeting and keeping their equipment on the military reservation, which would make unnecessary any outside armory for their use. Such an organization could readily perform all its duties to the State serving as infantry, but it could at the same time be distinctly known and constantly prepared for service as the militia reserve of the fortification, with which it sustains the relations described."

General Arthur MacArthur in 1902 stated in an official report on this subject as follows:

"Referring to what has previously been said in respect of the excellence of emplacements and guns, a further declaration is made with great emphasis, to the effect that when all projected works are completed and armed the coast line of the United States will be practically impregnable against any hostile attack, *provided the guns can be properly manned* and the fire action thereof can be developed to the full limit of its useful effect.

"Considering all the elements that enter into the transaction, even the ordinary practice fire of a high-power gun is an event of national importance. In war there is absolutely no margin for a high-power coast-defense gun missing. To be effective to the end in view nearly every shot must be a hit. Such a condition of utility does not at present exist, but fortunately it is a scientific possibility which can readily be made an actual fact by the simple process of affording necessary facilities for proper artillery training and providing an adequate instrumental equipment, *together with a qualified personnel to manipulate the same.* * * *

"The artillery arm of the regular establishment is numerically strong enough to furnish hardly one-fifth of the force necessary to fully man all the coast defenses on a war footing. An emergency call for mobilization would undoubtedly be responded to by a large number of zealous but absolutely untrained men, destitute of everything excepting a patriotic desire to do some thing valuable in behalf of the Republic.

"The formation of an artillery reserve, therefore, composed of men having some knowledge of the coast service, is a problem of national concern. As time is one of the essential elements thereof, the expediency is suggested of stimulating the self-interest of states in which seacoast defenses are located, as the militia thereof would make the very best artillery reserve possible. If the various coast states could be induced to regard the problem somewhat in the nature of a local issue, a scheme could easily be worked out whereby all of their militia organizations could have annual training in the batteries at comparatively small expense to either the States or the nation. In several instances state organizations have been designated for this duty, which only emphasizes the fact that all state troops contiguous to sea forts should receive training of this kind, as in case of emergency the entire body of militia contiguous thereto would hardly be more than half enough to raise the garrisons to a war footing.

"The foregoing remarks and the admirable service rendered by the Massachusetts regiment and the coast artillery companies of Connecticut in the recent maneuvers suggest a third important

conclusion as the result thereof, to the effect that the states of interest be invited to confer with the War Department with a view to the formulation of practical methods whereby this important training may be imparted to the largest number of men possible."

The efforts of Secretary Root may properly be said to mark the real beginning of our present *Coast Artillery Reserves*. Surprising progress has been made both as to efficiency and numbers. Very few of our regular artillery officers believed in 1902 that in eight years we should have made so much headway in bringing into being a force of militia troops which promises well with continued effort to become a valuable aid in manning our coast forts, should the emergency arise. Secretary Root in this as in his other public services looked far into the future. It is to be hoped that the ideal he had in mind may be reached and that the efforts made in that direction by the Chief of Coast Artillery may be successful.

For some time the attempts to get organizations of the National Guard to take up this work seriously seemed rather futile, but during the past three or four years there has been such a marked improvement, not only in the number who are willing to undertake it, but in the spirit with which it is undertaken, that the greatest hopes are now entertained by the Chief of Coast Artillery and others immediately interested in the work. With continued efforts for improvement the Coast Artillery Reserves should become an effective aid to the regular Coast Artillery in furnishing a personnel sufficiently instructed to man the coast armament at the outbreak of war.

The instruction of a number of the organizations seems to have advanced to such an extent now that with the present method of organization and control it appears to be a struggle for them to retain the point of efficiency which has been reached. Pertinent to this idea may be quoted an extract from an official report made in 1909 by the Commanding Officer, Fort Wadsworth, New York, regarding the Ninth Coast Artillery District, National Guard of New York, which is as follows:

"This organization is not as yet, in my opinion, up to its maximum limit of efficiency, but another tour of duty at a post, such as the one just concluded, will probably bring it to that limit. Thereafter it will be a struggle to keep it at that point of efficiency unless either the methods and facilities of instruction can be improved or the time for such instruction materially extended."

The question of extending the time is one that of course depends to a certain extent upon the personnel of the organization and more upon financial assistance by the federal government. Efforts to increase the length of the exercises have been partially successful and it may be hoped to continue with some slight successes in this line in the future. Methods and facilities for instruction are not all that could be desired. It is believed that great improvement can be made in this without legislation. There is at present no head—no chief—whose sole duty it is to look after the Reserves. The Division of Militia Affairs bears to the Reserves the same relation as did the War Department to the Coast Artillery before the latter got its corps organization.

Under that antiquated system individuals struggled, unsupported, making here and there local successes. Artillery regiments progressed largely in proportion to the efficiency of their commanders. With the Coast Artillery Reserves we see now precisely the same errors repeated. There is lack of *coordination*, lack of *uniformity in instruction*, lack of *uniformity in requirements*.

In the regular Coast Artillery since the corps was organized, there has been an unhesitating progress in efficiency permeating the *whole organization*. The progress has moreover been *uniform*. Officers now work with a better spirit; they see their duties more clearly; they have a leader who looks after their interests at the War Department; their work has intelligent direction and supervision.

The Chief of Coast Artillery has at present practically no control over the reserves. They are cast adrift, so to speak. Most everybody claims them as something worth having, but when it comes to helping them, somehow everybody promptly becomes busy about other duties. The fact of the matter is he doesn't exactly know how to give the help. There is a lack of authority, and hence a lack of responsibility.

The *first army* composed of regulars and national guard has been organized; a proper and responsible head has been assigned; a complete organization has been, so to speak, created for its control. The poor Coast Artillery Reserves must now feel more than ever adrift. "Just keep on drifting a little longer; you are about ready for proper organization and your efforts will in time demand *proper recognition*."

The reserves have had a difficult time in getting really necessary information. The sources of information have a way of *losing themselves*. Even with regular officers who devote their entire time to this work there is difference of opinion almost daily

as to what is the latest authoritative information on any subject. All of this is evidence of progress, of course—to the regular, *a puzzle to the reservist*. After being absent from the corps for several years the writer found that he had much to study in order to catch up with the work to which the corps had advanced during his absence. The effort would have been less difficult had our information been less scattered. Many pamphlets, orders, circulars and memoranda, not to speak of bulletins, engineer mimeographs, artillery notes, etc., have necessarily come into being due to the rapid advancement made under the corps organization of the regular Coast Artillery. About 85% of the information given in the medley above mentioned has become obsolete, and it is not difficult to understand the confusion of a reserve officer who tries to inform himself on the subject of Coast Artillery when he gets before him this conglomeration of a nearly endless variety of publications, some of which have been revised *ad infinitum*. This statement is not made with a view to criticizing the method of giving out such information. As has already been stated, the advance under our corps organization has been so rapid that this is the only method whereby such information could be promptly disseminated.

Much of our Coast Artillery armament has now been standardized and it has been practicable to *codify*, so to speak, most of this information into a single volume. This has been largely accomplished by a publication that has recently come out entitled "The Service of Coast Artillery," by Captain F. T. Hines, of the regular service, and Major F. W. Ward, of the National Guard of New York. Not only for the Reserves, but for the regular Coast Artillery, a work of this kind should now be kept up-to-date and a sufficient number of copies furnished for the instruction of the regular Coast Artillery and the Coast Artillery Reserves.

In general, after a suitable organization has been made for any national guard troops and the proper spirit started among them, the ultimate efficiency of such organization will depend upon the amount of assistance it will obtain from the state and from the national government. The states and cities have gone far beyond what the national government has done toward helping these organizations in obtaining what is necessary for their proper instruction. Experience in the past shows that, in order to obtain proper assistance from the national government for organizations of this kind, it is necessary first to proceed to the limit of efficiency with what is now available. Therefore it

is the duty of the officers, regulars and reserves, to develop to the point of greatest possible efficiency the Coast Artillery Reserves under the present legal status.

For a first improvement and with the ultimate object of organizing a national corps of Coast Artillery Reserves, a rough skeleton organization somewhat on the following lines is suggested:

1. Divide all Coast Artillery Reserves into groups, each group approximating in size three regiments of infantry or less. This grouping should be done regardless of states except that the reserves of one state should not be split up to form parts of different groups, but the reserves of two or more states may be combined in one group.

2. Assign to each group thus formed a regular officer of experience who shall devote his whole time to the instruction, equipment, organization and proper recruitment of his group.

3. Assign to each officer in charge of such group a suitable number of selected non-commissioned officers of the regulars as assistants—one for each four companies (fire command) is suggested.

4. Assign as Assistant to the Chief of Coast Artillery at Washington an experienced officer of Coast Artillery in charge of Coast Artillery Reserve affairs.

5. Place in the Chief of Coast Artillery the same general authority and responsibility in regard to the instruction and training of the Coast Artillery Reserves as he has now for the regular Coast Artillery.

The officers in immediate charge of local groups might well be placed on the staffs of department commanders, as are now the coast defense officers, but they should be left free from other duties in order that they may devote their entire time to this important work of building up into a uniform system of training the instruction of the reserves.

After work has progressed under such a system for several years a further development will doubtless result in a reorganization of local units and perhaps the assignment to each reserve fire command of a regular officer, or a reserve officer paid full salary by the federal government.

Under such organization the department commander can use similar administrative control over the reserves as he does now over the regulars, but the *technical instruction and training* will be in charge of the Chief of Coast Artillery, as it is now for the regular corps, and this is the *only control that can in the end bring the reserves up to the standard of efficiency necessary to make them*

an effective auxiliary to the regular corps for manning the coast forts.

The development of the reserves into an organization as above outlined is of course simplified by the splendid and successful example of the regular Coast Artillery, which by its organization and through its tactful and efficient chiefs has overcome nearly all natural and unnatural obstacles, has become efficient in instruction and technical training, and has built up a spirit among its officers and splendid non-commissioned officers which weeds out the drones and no longer permits the inefficient, no matter whether they have *influence* or not, to hold the important and responsible positions upon which depend so much the constant preparedness for war. By these methods the regular corps has so advanced in all lines that it is able now to assume more and more the local work and responsibilities of the three artillery supply departments, *i.e.*, the Engineers, Ordnance and Signal Corps, and the time is not far distant when within its limits the corps will possess all the technical training and expert knowledge necessary to plan its fortifications, construct them, and install its complete fire control systems and other communications.

The Engineer Corps and Signal Corps could, if other considerations demanded it, be wholly eliminated from the construction and maintenance of fortifications—such has been the advance in the artillery under a proper organization and a responsible head. The reserves cannot even begin to make corresponding advances until they have at the War Department a responsible and efficient leader with an organization suited to transmit to the various elements the necessary information for their guidance not only for the technical instruction but for their proper equipment as well. They must have at the War Department a head which will see that the real needs of this important auxiliary to the defense are not laid aside for considerations of less importance. They must in fact have an organization all around that is consistent with the policy adopted by the Congress when it virtually accepted the views of Secretary Root in regard to Coast Artillery Reserves, as expressed in the extracts from his remarks at the beginning of this article

I would say to the reserves, "*Do not lose heart; you are doing well, and in the end your services will be recognized to their full value,*

EVEN BY THE FEDERAL GOVERNMENT.

PROFESSIONAL NOTES

COAST DEFENSES OF GERMANY

Translated from the Russian Artillery Journal

GENERAL REMARKS

The shores of Germany extend for about 200 miles along the North Sea and 596 miles in the Baltic. They consist for the most part of low and marshy land, with ill-defined outlines, and studded with sunken rocks, which greatly hamper navigation. The shores of the North Sea are fringed with islands, which form a long line parallel to the shore, but scarcely afford protection from the surf.

These islands are separated from the mainland by sand-banks or shoals, which are usually uncovered at low tide.

The shores of the Baltic are indented by many bays, which in the west are called "fiords," and in the east "haffs"; the former are deep and hidden from the sea, while the latter consist mostly of lagoons and lakes, separated from the sea.

The depth of the North Sea on the German coast varies from 72-92 feet; this increases towards the north, but alternates with numberless shallows.

The tide which rises from 5-7 feet on the coast of Friesland reaches 8 feet at the Jahde and about 10 feet at the estuary of the Elbe. A north-westerly wind which pens up the waters in these wide river-mouths has a great influence on the tides.

At the time of the equinox the tide rises sometimes as much as 20 feet above the ordinary.

The depth of the Baltic varies from 53 feet to 756 feet. On the German coast it seldom reaches 150 feet; at Schleswig-Holstein, about 100 feet; at the mouth of the Swine barely 30 feet; at Rugenwalde, 36 feet; 42 feet at Colberg; 66 feet at the mouth of the Stolpe.

On the Pomeranian coast the depth becomes greater, sometimes 250 feet and at Danzig 370 feet.

On account of the number of rivers flowing into the Baltic, and the narrow connection of this sea with the ocean, the water is only slightly saline, the salinity being only $\frac{1}{10}$ instead of the ocean salinity of $\frac{1}{8}$. In consequence it freezes readily along the shore, especially the northern shores during December. The tide is hardly perceptible. In short, the German shores of the North Sea are flat muddy wastes which make navigation difficult, and would keep a hostile fleet far from the coast, while the depth of water required for warships can be found only at a great distance from the land.

On the other hand, the German Baltic shores, indented by many inlets, afford good harbors, although in many places their depth leaves much to be desired.

Along the whole extent of the coast, there is an extensive and imposing system of fortification. The greater part of these defenses are of recent construction, and are armed with guns of the latest pattern.

A strategical railway runs along the whole coast of Germany, beginning at Emden and ending at Memel, linking up all the ports together; from Emden near the Holland frontier it proceeds to Bremen, Hamburg, Lubeck, Stettin, Danzig, Königsberg, and finishes at Memel on the Russian frontier; special branch lines connect those ports which are far removed from the main line, which again is connected with the interior of the country by 20 different railways.

Altona on the Elbe is the center of the whole system of coast defense on account of its proximity to both seas; it is connected by underground cable to Berlin and the various points of the coast.

The administration of the whole coastal defense of Germany is vested in the Admiralty. It not only controls the defense of the naval ports, but also the coast fortresses and all the fortified points. "United action by both land and sea," that is the strategical motto which is accepted by the organization of Germany's modern coast defense.

Thanks to this unity of administration and command and equally to the good organization of the whole system generally, and particularly the naval defense which includes numerous squadrons of mine boats and a splendidly handled flotilla of submarines; Germany possesses at the present time far and away the best conceived and the best worked-out system of coast defense in Europe.

For administrative purposes the coast is divided into two sections.—The Baltic and the North Sea. Each section is under a Vice-Admiral, who has the control of both a military and naval personal staff. He is assisted by a rear-admiral, a fleet inspector (who fulfills the duty of our chief of the staff) and who replaces the section commander in his absence, an inspector of naval ordnance, to whom the permanent fixed defense is subordinate, and also the batteries and mines, an inspector of marine infantry (a Colonel), at Kiel only; an inspector of mines, to whom are allotted the automatic mines and the submarine torpedo mines.

The naval arsenals are at Kiel on the Baltic, and at Wilhelmshaven in the North Sea in the bay of Jade.

The Imperial dockyard is at Danzig, the former arsenal, at the present time in charge of a naval captain.

The chief naval establishments are:—

The naval school, the naval academy at Kiel, the artillery college on board ship at Wilhelmshaven, the Torpedo school on two ships at Kiel, and the engineers school at Kiel.

The naval stores are distributed between Kiel and Wilhelmshaven. The naval artillery, on whom devolves the task of manning both the batteries ashore and the guns on board ship, are divided between Wilhelmshaven, Friedrichsort and Lehe, at the mouth of the Weser.

The sub-marine defense is divided into the fixed and movable. It includes a large depot at Friedrichsort; four chief stations, corresponding to four coastal districts at Wilhelmshaven, Kiel, Stralsund and Danzig, and sixteen minor stations; seven of these are first-class:—

Geestemünde, Cuxhaven and Arosund* on the North Sea, and Trave-

* Have been unable to locate this station.—Translator.

munde, Swinemunde, Pillau and Memel on the Baltic sea; nine others are second class: Wangeroog, Neuwerk, and Keitumsylt on the North Sea, and Apenrade, Flensburg, Sonderburg, Duppel, Warnemunde and Colberg on the Baltic. Besides these, there are two torpedo stations at Kiel and Wilhelmshaven, and two battalions of marine infantry, one at each of these ports.

At the island of Heligoland, there is a large depot for torpedoes and submarine boats. Stations for launching torpedoes supplement the defense of all the great ports, especially at Kiel.

Berlin is the headquarters of the Admiralty, of the Admiralty Committees, of the various technical departments, and the hydrographic institute.

The naval and coast artillery have four general depots; at Wilhelmshaven, Cuxhaven, Geestemunde and Friedrichsort.

The principal guns are of the following calibers, amongst which those most often met with in coast fortresses are distinguished in the accompanying table by stars:—

Calibre in inches.	Weight.		Initial velocity in feet per sec.	Weight of charge in lbs.
	Gun in tons.	Projectile lbs.		
17.7	155	3480	1968	1240
15.7	72	1880	1647	590
14.3	75	1390	—	653
13.9	52	1280	1640	280
* 11	27.5	568	1558	141
* 10.2	19 & 18	464	1574	117—139
* 9.4	19	520	1656	56—73
* 8.2	10	236	1454	46
* 5.9	4.1	120	1624	17
* 4.7	1.4	40	1645	9.7

The chief armaments of the coast fortresses consists of 10" and 11" guns and mortars. Besides these, there are 6", 9.4", 14", and 15.7" guns and 8.2" mortars.

Both England and France have followed the example of Germany in the way of unification of the business of coast defense, alike in the sea and land department. Up to 1906, the organization of coast defense in England and France was of much more complicated character than at the present time; the naval ports, and the movable defense, consisting of ships of different types were governed by a naval department, whilst the shore batteries, forts and fortresses, and mines and other obstacles were directed by the military authorities.

From 1906, in England the defense of ports which relied up to that time principally on mines which as was shown in the Russo-Japanese war, are almost as dangerous to one's own ships as to those of the enemy (witness the destruction of the mining cruiser *Yenisei* in 1904) was concentrated in the hands of the naval authorities, and relied chiefly on the employment of strong torpedo flotillas of submarine boats (of the submersible type) capable not only of the defense of their own shores, but also of the attack of ships, at considerable distances away.

The whole coast of England is divided into six districts instead of nine as before, and at the head of each is a captain of the 1st rank, who commands the whole staff of the coast defense.

In France at the present time, the coast defense is organized in exactly the same manner.

Emden:—

A detailed map of the German Bight, showing the Jade and Weser rivers and the surrounding coastal area. The map includes the following features:

- Islands and Coastal Features:**
 - I. of Wangeroog (Wangeroog Island)
 - Rotensand Light
 - Ebersand Light
 - Meyer-Lodge Light
- Rivers and Waterways:**
 - The Jade (Jade River)
 - The Weser (Weser River)
 - Jade Bay (Jade Bay)
- Forts and Military Installations:**
 - Fort Wingen
 - Fort Shillingborn
 - Fort Korumerzill
 - Fort Knipphausen-Zill
 - Fort Schaar
 - Fort Groden
 - Fort Heiligen
 - Fort Marienzil
 - Fort Austerzill
 - Batt' Davensfeldt
 - Supporting Battery
 - Batt' Hoppens
 - Batt' Ekvarden
 - Fort
 - Fort Langloutien II
 - Fort Langloutien I
 - Batt' Brinkhof
 - Brumerhaven
 - Geestemünde
- Other Locations:**
 - Wilhelmshaven
 - Fort Brinkhof
- Scale:**
 - 0 1 2 3 4 5 6 7 8 9 10 miles

THE JAHDE, WILHELMSHAVEN, AND THE WESER

From the Dollart Bay, to the N.E. of Ems stretches in an unbroken line, parallel to the shore as far as the Jahde, the islands of German Friesland of which the most important from a naval point of view are:—Borkum and Wangeroog, which have signal stations, semaphores and electrical lighthouses.

The Jahde:—

The Jahde is an arm of the sea, into which falls a small river of that name. This arm is divided into an outer and inner bay. Briefly, the bay is a broad

marshy basin, uncovered for the greater part at low tide, and intersected by narrow channels.

The chief entrance to the Jahde is by the Wangeroog channel between the shores of this island and Jahde-Platte, width 1,760 feet, and 33 feet in depth. It traverses the whole bay under the name Vareler-Tiff.

Beginning at Wilhelmshaven, it increases in width and breadth, and ends in two channels which terminate in the mud.

The entrance to the Jahde is protected on the east by shoals and on the west by:—

A fort built on the island of Wangeroog.

A fort and several batteries Mingen.

The batteries of Schillinghorn and Korumersil.

These defenses are armed with 13" guns, firing from armored cupolas, 11" guns, 120 mm. Q.F.'s and 9" and 11" mortars.

Wilhelmshaven:—

Although it is only 40 years since this port was constructed, it possesses splendid works, which place it on a level with the 1st class naval ports of Europe.

Wilhelmshaven roads afford good anchorage to ships, opposite the harbor, having a depth of from 40 to 56 feet.

The naval port possesses all the latest requirements. It is lighted by electricity, as also are the stores and shops. The principal basin has an area of about 30,000 square yards. The shipbuilding yard is connected on one side with the arsenal, and on the other with the former commercial port by underground ways. The new commercial port, to the west of which ends the canal from Ems to the Jahde (47 miles in length and connecting Wilhelmshaven with Ems), has an area of 81,000 square yards and is connected with the old port by a canal.

Since 1870, defensive works have been erected at Wilhelmshaven.

On the sea-front there are:—

Fort Heppens, armed with 19 guns, in front of which is a supporting battery with 7 guns; the battery Dauensfeldt, armed with 15 guns of large caliber. These three works extend along the western shore of the bay, and to the north of the cape, on which Wilhelmshaven stands.

The battery Ekwarden on the eastern side of the bay is opposite Fort Heppens. Besides this on a sand-bank, situated between Wilhelmshaven and Ekwarden, is another work, which commands the passage and is connected with the mainland.

The land side is defended by:—

Fort Rusterzil, which can at the same time operate over the sea and land sides. Its gorge is protected by a double iron railing, the ditches are filled with water, and in case of need the interior of the fort can be submerged by means of a sluice.

Fort Kniphauser-Zil. Fort Shaar. Fort Groden. Fort Heiligen. Fort Marienzil.

Three of these forts, Rusterzil, Shaar, and Marienzil are situated about 3½ miles from Wilhelmshaven and are connected to it by rail.

Wilhelmshaven is connected by submarine cable with Berlin, Hamburg, Kiel and Emden. It possesses a Naval Artillery School.

As it is a principal supporting point for the fleet in the German ocean, and the principal point of the naval section of the North Sea, Wilhelmshaven is at the same time the center of two sub-sections; Geestemunde and Cuxhaven.

Taking into consideration the artificial and natural defenses of Wilhelmshaven, its forts and batteries, the narrowness of the fairway, the facility with which it could be defended by mines, its distance from the open sea, and finally the impossibility of entering the Jahde without buoys, one may say that Wilhelmshaven is fully secured from any direct attack from a hostile fleet.

The Weser:—

The mouths of the river Weser, border on the estuary of the Jahde, from which it is separated only by the shoals of Khogevege. This river has two entrances into the North Sea, the old and the new Weser. Only the flood tide will permit ships, drawing 25 feet to come up the river but they can always, in spite of ice, reach Bremerhaven, the advance port of Bremen, as the Weser is never completely frozen.

The mouths of the Weser are defended by four heavily armed forts, two on each side. On the right or eastern bank:—

Fort Trusum or Brinkalhof is armed with four armored cupolas, of which three have two 11" guns each, while the 4th—on the land side—has two 6" guns.

The armored battery Brinkalhof to the south of the above-mentioned work is armed with ten guns of 8" caliber.

These works are furnished with hydraulic machinery for revolving the turrets, and for working the guns. The engine is on shore between the two. It will allow three turrets to be worked at once, and thus works six heavy guns.

On the left or western bank, the great sand-bank Laugloutien has:—

Fort Laugloutien.—Zand No. 1, an armored battery with nine 8.2" guns.

Fort Laugloutien.—Zand No. 2, to the north of the above, provided with six armored cupolas of which five are armed with one 11" gun each, and the sixth with two 6" guns, on the land side. In both these forts, the working of the turrets and guns is done by hand; a complete revolution of the turret takes two men six minutes. From these guns, 36 rounds can be fired in an hour. These turrets are lighter than those on the right bank.

The total weight of armor, used in these works amount to 7,529 tons. At a price of 28 roubles a ton, this works out at £333,000 for armor alone. With the exception of the armored battery Brinkalhof, these forts are built on sand-banks which are uncovered at low tide.

A strong iron railing protects these works on the left side of the river from an unexpected attack. Although the fairway of the Weser is sufficiently broad, and suitable for the passage of ships, nature has assisted its defense by means of sand-banks which are plentifully distributed along its course. These banks which are situated to the west of the fairway, are steep, so that deeper water is soon reached by steering from them towards the east. The banks of the river are not well adapted for a disembarkation.

Geestemunde—Bremen:—

On the left bank of the river Geeste, three or four miles above Bremen-haven, is the little port Geestemunde which is the center of one of the subsections of the Wilhelmshaven sections, and which serves as a 2nd class torpedo station.

Bremen, the second town in Germany, for its shipping, possesses naval work-shops which can build naval vessels of small draught. There is also a small iron floating dock.

The Elbe:—

To the east of the Weser estuary stretch sand-banks, separating it from the estuary of the Elbe, which is itself divided into two by the banks Gross-

Fogel and Medem. The Elbe is the largest river in Germany from a commercial point of view. Studded with banks which are intersected by narrow channels and extend seawards for 20 miles, this estuary presents the same difficulties to navigation as that of the Weser. The tide ordinarily is felt as far as Hamburg. The only channel, available both by day and night for large ships is the Nordergat.

Between the mouth and Hamburg are:

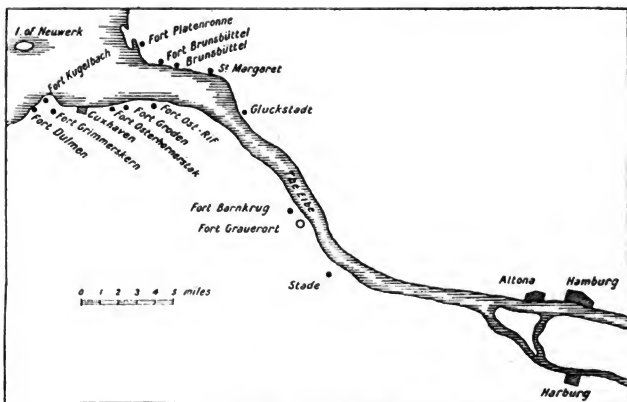
On the right bank, Brunsbüttel, Gluckstadt, Altona, Hamburg.

On the left, Cuxhaven, Stade and Harburg.

The mouth of the Elbe, like that of the Weser is protected by many powerful forts which are:

On the left bank, i.e., the west:—

1. The defenses of the island of Neuwerk which is armed with seventeen 7" guns. The island of Neuwerk is connected with the mainland by cable and has a semaphore.



MOUTH OF THE ELBE

2. Fort Kugelback; this is a closed earthen redoubt, very well armed (eight heavy guns), and situated on the western extremity of the estuary. To the west it is supported by a supplementary battery.

3. Fort Grimmerskern, situated on the shore to the N.W. of the town of Cuxhaven, and armed with eight heavy guns; an earthwork.

4. Fort Cuxhaven at the entrance to the port.

5. Fort Dehse or Dulmen, westward of the two preceding ones. This fort has three armored cupolas armed with thirty 5" guns.

6. Fort Osterhornerstak (6 guns).

7. Fort Groden (8 guns).

8. The armored battery Ost-Rif, situated to the S.E.

9. Redoubt Barnkrug (5 guns).

10. Fort Grauerort (10 guns) earthworks, very heavily armed.

These two last are in the 2nd line on the heights of Stade, and fire over the fairway.

On the right bank, *i.e.*, the east:—

1. The armored battery Westerdyk or Matenroune situated south of Marne.
2. Fort Brunsbützel.

Cuxhaven, situated on the left bank is from a strategic point of view, the station for the fleet in the mouth of the Elbe, a port of refuge for gun and torpedoboats, and a depot of mines for defense for this portion of the coast-line and the entrance to the canal from the North Sea to the Baltic.

Cuxhaven is a harbor, 350 feet wide and 1050 feet long, and from its position as well adapted as a base for the fleet.

Brunsbützel:—

Is a small port, defended by a fort of the same name.

Glockstadt is a town of 20,000 inhabitants, it has an arsenal and Naval School.

Harburg:—

Is a free port, situated on the left bank opposite Hamburg. The town is fortified, and has a citadel and dock for transshipping goods from sea-going to river boats and vice versa. It is connected by rail with Hamburg.

Hamburg (710,000) is the 2nd town in Germany in population and the first in trade, is situated 70 miles from the sea and 56 from Cuxhaven; it has most extensive docks.

Below the town of Altona, the Elbe with its islands and channels is more than 10 miles wide, which increases as it approaches Cuxhaven.

Canal from North Sea to the Baltic:—

It goes from the estuary of the Elbe, between Brunsbützel and Saint Margaret, 40 miles below Hamburg and 15 miles from Cuxhaven in a northerly direction; making use of various lakes and streams it reaches the town of Rendsburg where it unites with a previous canal and ends at Holtenau, between Friedrichsort and Dustembrok in Kiel harbor.

This canal at its western end is protected by the fortifications of the Elbe estuary, and at the eastern end by the fortifications of Kiel, and especially Friedrichsort.

Its total length is about 65 miles, its breadth at the top from 210-230 feet and 85 feet at the bottom; its depth is from 28-29.5 feet. The canal besides saving time, saves ships from the dangerous voyage round Cape Skagen. Completed in 1905, it affords possibility to the German fleet of an easier and shorter journey from one sea to the other.

This canal, which makes the blockade of the Elbe, Weser, and Kiel ports a difficult matter, and affords an absolutely safe haven for both war and merchant ships, presents, in conjunction with the Elbe estuary and Kiel Harbor, a good example of an inland water route going from port to port along the coast.

The North Friesland Islands:—

The western shores of Schleswig-Holstein, are fringed with numerous large sand-banks, and in consequence are hardly accessible to battleships, they, therefore, are provided with no works of defence.

From the mouth of the Eider to the Denmark frontier extend the North Friesland Islands, of which the principal are:—

Nordstrand, Pelworm, Amrum, Fohr, Sylt, Romo and Fano. They are connected by telegraph both with one another and with the mainland, and in addition Sylt, the largest is connected to the shore by two cables.

Heligoland:—

The island of Heligoland in 1890 was ceded by England to Germany, who attached the greatest importance to its acquirement. It is situated at almost

equal distances from the Ems, Weser, and Elbe mouths and is 35 miles N.W. from Cuxhaven. As a port of refuge for a fleet, it is of little value but its position is of the highest importance as a coaling station and a permanent station and harbor for mining and torpedo boats, as forming a base of operations and a center for the purpose of furnishing a hostile fleet with supplies (as it was in the time of the wars of Napoleon the 1st and during the blockade of the German shores by the Danes in 1848) and lastly in consequence of its lighthouse, as a guiding mark indispensable for the navigation of these shores.

Heligoland is one mile in length and 650 yards in breadth. It is composed of a mass of red sandstone which in all sides presents vertical cliffs varying from 100 to 175 feet in height. On the N.E. it is surrounded by very dangerous banks and reefs, which form two open roadsteads one to the N.W., another to the S.E. Nord-Haven has a depth of 23 feet and Sud-Haven 13 feet. The town which is on the S.E. end of the island is divided into an upper town built on a cliff nearly 200 feet above the level of the sea, and a lower town on the sandy beach.

The Germans have restored the defenses of the island which were begun by the English and have erected the following works:—

1. A battery with armored cupolas on the southern extremity (100 ton guns) at a height of about 175 feet.

2. A battery also with armored cupolas (38-ton guns), on the western side.

3. A mortar battery (11" mortars) in the center of the island.

Thanks to the high position of the batteries, their guns which are almost invulnerable, can fire over the sea all round; a naval blockade of the Weser and Elbe estuaries and the entrance to the Kiel canal will thus be greatly hampered.

Besides this the island possesses a natural defense; the steep cliffs are very difficult to scale on the North and are quite inaccessible on the south side.

On the south of the island a tunnel has been made 700 feet in length which leads by a slope from the shore to the summit of the island.

A lighthouse is built on the highest point and is 245 feet above sea level.

A signalling station has been established at the old lighthouse S. S.E. from the present one. The island is connected with the mainland by two cables, from Cuxhaven and Schillinghorn at the entrance to the Jahde, which enables the island to communicate with Wilhelmshaven. The station for torpedo and submarine boats is at the eastern side of the island.

With regard to the present strategical importance of Heligoland, as a station for torpedo and submarine boats, the Germans are of opinion that its acquirement makes the blockade of the North Sea coast from Borkum to Sylt, an extremely difficult problem.

The blockading fleet (England's for instance) would have not only to expect attack from the front, but both of its flanks would be constantly threatened.

On this account opportunities would often occur for raids on the estuaries and ports of the east coast of England and attacks there, by means of the torpedo and submarine-mining flotilla, on the ships of the English fleet.

From this we see, that with the acquirement by Germany of Heligoland, the strategical position of the German fleet in the North Sea is immensely strengthened, and with the cutting of the Kiel canal which permits a German fleet to be taken at will from the North Sea to the Baltic and back in a very short time, this fleet will for certain hold a dominating position in the Baltic.

—*Journal of the Royal Artillery*, February, 1910.

THE PANAMA CANAL; ITS STRATEGIC AND ECONOMIC VALUE

(A Lecture delivered at the Royal Artillery Institution, on Thursday, October 28, 1909.)

By Major E. M. PAUL, R. E.

Colonel A. Graham Thomson, Commandant, Royal Military Academy, in the Chair.

THE CHAIRMAN: General Belfield, ladies and gentlemen; I have much pleasure in introducing Major Paul who is going to lecture on the Panama Canal with special reference to its strategic and economic value.

THE LECTURER: Colonel Graham Thomson, General Belfield, ladies and gentlemen: There are so many questions of interest which have a direct bearing upon the Panama Canal—or as it is sometimes spoken of as the Isthmian Canal—that it is difficult to know where to begin, how much to include and where to end.

It is assumed that the audience is well aware where Panama is; that it is a port on the Pacific coast of the Isthmus of Darien, or as it is now called, the Isthmus of Panama, which unites the North and South American Continents.

Colon, or to give it the full name Cristobal Colon, the other port on the Caribbean Sea, is named after Columbus, who discovered the West Indies in 1492, and is generally credited with the discovery of the Americas, though it is almost certain that the North American Continent was discovered by Amerigo Vespucci, an Italian in the service of Spain, and Sebastian Cabot, a Venetian in the service of King Henry VII, in the year 1497; hence the name America.

Colon, Columbus, and Caribbean, all commencing with the letter C, will fix that in one's memory.

Now to go a little into the confines of history to ascertain when the first idea of a sea passage across the American Continent was conceived, we must carry our minds back to the days before the Spanish Armada sailed against England.

Christopher Columbus,—a native of Genoa—in 1492 sailed from Lisbon away to the West seeking passage to India so as to avoid the long voyage round the Cape of Good Hope, which was the only route known in those days.

Landing on the Island of San Salvador, one of the Bahama Group, he thought he had reached the coast of India, so he called this land the West Indies. Setting sail again he coasted along round the Gulf of Mexico and Central America making further discoveries—all of which lands he claimed as new territories in the name of the King and Queen of Spain.

In one of these journeys he is believed to have landed at Colon and explored the Isthmus.

Following the tracks of Columbus and his lieutenants, many adventurers left Spain attracted by their tales of the marvellous treasures of the New World.

Amongst these were Balboa, Cortes, and Pizarro. Balboa in 1513 made discoveries on the Pacific coast, Cortes explored and conquered Mexico, 1519-1521. Pizarro explored the South American coast and conquered Peru, 1525-1532. He made use of Panama as his base.

As a result of all these journeys and explorations it was found that no natural waterway existed in Central America connecting the two oceans. Whereupon the King of Spain, about 1520, sent out a man, Davila, to try and discover one.

He was a man of indomitable energy and great resource for he actually took to pieces the ships in which he had sailed from Spain and transported them across the Isthmus from sea to sea, a distance of about fifty or more miles, on backs of mules through an awful country of swamps and forests saturated with moisture and fever, over a mountain ridge without any roads whatever.

His efforts were rewarded, for embarking again in his rebuilt ships on the Pacific he discovered the great Nicaragua Lake, which was at one time considered, and still is by some, to be the best site for an Isthmian Canal.

The general result of these explorations was that in 1551 it was found that three routes were possible, those of Tehuantepec, Nicaragua and Panama. (Fig. 1.)



FIG. 1.

It was not till 1855 that any connection of importance, beyond a mule track, was made when the Panama railroad was opened from Colon to Panama.

Quite recently, 1907, a railway 189 miles in length has been opened across the Tehuantepec route; it has been built by Sir Weetman Pearson's firm of British engineers, who are joint owners with the Mexican Government.

The proposed Nicaragua Canal has been abandoned mainly for political reasons; the U. S. A. Government have obtained the right and are prepared to find the money to carry out the stupendous undertaking known as the Isthmian or Panama Canal.

With these historical preliminaries some idea of the physical character of Central America and the islands and shores of the Caribbean Sea may be referred to.

Perhaps it will be best to assume that we are making such a voyage of discovery as Columbus did, only nowadays we should have a well-defined route to follow.

After crossing the Atlantic we should reach the Island of Trinidad which lies off the coast of Venezuela, and in coasting along we should pass the harbor of La Guaira whence a railway climbs the mountains to the very fertile valley—elevated some 3,000 feet above M.S.L.—where the capital, Caracas, stands. Great quantities of tobacco, cocoa and coffee, bananas and sugar—in fact almost anything—can be grown in these countries, but owing to lack of roads and railway communications it is not possible to bring it down to the coast for shipment.

Steaming westwards we should skirt a coast-line with cocoanut palms all along the sea shore—very characteristic of these countries, with high lands behind them and plateaux and in some cases grass plains and dense forests beyond.

On our right we pass the Island of Curacao—which belongs to the Dutch; it is an island of considerable strategical importance, lying as it does comparatively near the Caribbean entrance of the Panama Canal. Further on is the Gulf of Maracaibo, and then Columbia.

Here it may not be out of place to refer to other islands of importance in the Caribbean Sea, viz., Barbados, St. Lucia, Jamaica, (British), Cuba, Puerto Rico, (American), separated by the negro Republics of Haiti and San Domingo. British possessions on the Continent are British Honduras and British Guiana.

It should be noted that at present Germany has no strategic position in the Caribbean Sea.

Passing by the great Gulf of Maracaibo we sail south-west and disembark at Colon.

This town was built on ground but very few feet above sea level, and in the rains the whole of the ground underneath and around the houses was not infrequently deep in water and mud. The site in fact was a swamp at the mouth of the Chagres River. Until recent years it had a bad reputation and was very insanitary; it was mainly inhabited by negroes from Jamaica, Martinique and other islands until it passed into the hands of the French and, later, Americans.

The United States Government has, however, done much by sanitary measures to improve the place, and is raising the general level of the town with "dirt" excavated from the Canal.

At one time yellow fever (yellow "Jack" as it is familiarly called by sailors) was very prevalent, but it has almost been stamped out.

The most important part of Colon and the healthiest in which to live, is Cristobal Colon point, where the quarters of the American engineers and officials of the Canal Zone are located. This is the white man's quarter.

From Colon a railroad, 47½ miles in length, runs to Panama. It took seven years to build and was opened so long ago as 1855. The discovery of gold in California promoted the construction of this railroad.

The route taken is shown in Fig. 2.

Until a few years ago it was only a single line, five feet gauge, but since the Americans took in hand the building of the Canal it has been relaid with double tracks, properly ballasted and re-aligned. In building this railway a great number of Chinese and negroes were employed, and very many died owing to the deadly character of the climate. The line passes through dense jungle of gigantic trees and bamboos.

The jungle is very thick, and owing to the excessive rainfall (128 inches a year) coupled with a high summer temperature all the year round (averaging 80°), vegetation is of very rapid growth.

This intense humidity fosters luxuriant rope-like creepers which hang from tree to tree and render passage through the forest on foot very tedious; progress for any party of explorers is only possible by the free use of the *machete*—a kind of cutlass.

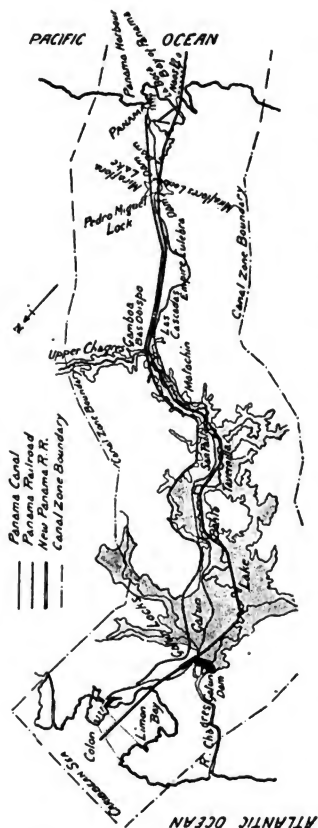


FIG. 2. MAP OF CANAL ZONE, SHOWING THE GREAT LAKE THAT WILL BE FORMED BY IMPOUNDING THE CHAGRES RIVER AT GATUN; SITE OF LOCKS; LINE OF NEW RAILWAY, ETC.

This continuous hot-house condition of affairs produces great lassitude and enervates the white man, quite apart from disease.

Most persons after residence of a year or two on the isthmus get their

blood saturated with malaria, which often recurs when the individuals return to a temperate climate.

The chief river of the Isthmus is the river Chagres, which rises about the center of the Isthmus and takes a bend at Gamboa, discharging into the Caribbean in Limon Bay.

Fifty years ago enormous mahogany and greenheart trees grew on the forest covered banks, but were mostly felled for providing railway sleepers and buildings, and for export.

Nowadays one has to go further into the mountain valleys of the interior of the Isthmus to obtain well-grown mahogany trunks. The usual plan is to haul or roll the felled trunks to some river and float them to the nearest railway station or seaport. Sometimes the streams are dammed up so as to float the logs. This is a long and tedious process so that two or even three years may elapse before a very large mahogany tree trunk will reach the hold of a ship from its place of growth.

The railway terminus at Panama on the Pacific lies between the suburb of La Savanah and the city of Panama. The modern city of Panama is situated on a volcanic plateau jutting out into the sea, and its site is some five miles S.W. of that of the original city founded by the Spaniards in 1517.

It was used by Pizarro and his companions as their base for the conquest of Peru between 1525 and 1532. For forty years the city increased and became a place of considerable wealth and importance because of the prosperous commerce between Spain and Peru.

Its wealth attracted French and English pirates, who in 1571 utterly destroyed it. The terrified inhabitants fled and settled where the modern city now stands.

For two hundred years and more, *i.e.*, until one hundred years ago, the present city of Panama was very prosperous and the center of a great trade crossing the Isthmus to and from Spain and Europe. Everything was carried on mule back as there were no proper roads graded for wheel traffic. Since then it has suffered many vicissitudes and changes.

The streets are generally narrow, filthy and ill paved, but since the city came under American control, drastic sanitary measures and proper drainage and paving have been adopted.

The population consists of some 20,000 souls, of whom one-third are negroes. Most of the influential and prominent Panamanians are of Spanish descent.

To the north of the city is Mount Ancon—an extinct volcano about 500 feet high,—near the foot of which is a very fine hospital, built by the first Canal Construction Company, a French company engineered by M. de Lesseps, and considerably improved and enlarged by the U. S. Isthmian Canal Commission.

The buildings are erected on terraces and the hospital grounds are laid out as a fine park.

The U. S. medical authorities have taken every precaution and adopted drastic measures as in Cuba to stamp out yellow fever. It is now a confirmed fact that yellow fever is propagated by a house mosquito which gets the microbe into its body and passes it into a person as it bites and draws blood, consequently the houses are provided with copper wire gauze shutters to render them mosquito proof; war was also carried into the enemies' country by sub-soil

drainage, filling in and oil treatment of the stagnant pools—the mosquito breeding grounds.

Since the occupation of the Canal Zone, the Americans have expended about £2,750,000 upon sanitation and municipal improvements, and the money has been well expended, the reduction of mortality being very marked both in white and colored races. During August, 1907, the worst season, the death rate did not exceed 8.57 per thousand, which is much less than in New York.

Employees are housed free and provided with many hygienic comforts, in the matter of water supply, baths, telephones, electric light, ice, etc., and good supplies imported from the states are sold at cheap rates.

Government schools, clubs, hotels, hospitals, laundries, bakeries, and ice factories, are provided in various centers and well equipped.

It has been stated that the U. S. Government has control of the cities of Panama and Colon, and it will be fitting here to trace how this came about before passing on to the actual construction of the Canal.

To review the historical events, which led up to the commencement of the Panama Canal would occupy too much time. It has already been stated that the idea of interoceanic communication was first put forward in 1520. Suffice it to say that about the year 1823 the U. S. Government, as the outcome of the now famous doctrine of President Monroe, namely, "America for the Americans to the exclusion of all European influence in American schemes and from Settlements and Colonies," revived the old idea of an interoceanic canal first put forward three hundred years before (1520).

Routes were surveyed and finally the U. S. A. secured a concession to construct the Nicaragua route.

The scheme involved the canalization of part of the S. Juan river and the building of locks to reach the inland lake some hundred feet above M.S.L. Various difficulties, coupled with insufficiency of funds, prevented the realization of this project.

Meantime, about 1827, the Mexicans started a canal survey of the Tehuantepec Isthmus. The Mexicans never built their canal, but have recently carried through a railway instead, across the Tehuantepec Isthmus.

The Nicaragua Canal, for long a rival to the Panama scheme, eventually fell through, and the Panama route alone remained.

Next came M. de Lesseps, the great French engineer, who in 1869 constructed the Suez Canal, and wished to add to his reputation by cutting a Central American Isthmian Canal; he decided on the Panama route, a much more ambitious undertaking than the Suez Canal.

He set about getting a concession from the Columbian Republic in 1876, and in 1880 he got the scheme floated and work was commenced by the French Panama Canal Company.

The officials were paid on a very lavish scale; they lived luxuriously, and looked after their own rather than the shareholders' interests.

Small wonder then that in 1889 the French Company failed, having squandered £50,000,000, leaving two-thirds of the work untouched.

Bribery and corruption had done their work, and only one-third of the money had been honestly expended upon the Canal.

The failure practically killed M. de Lesseps, and with his death the scheme, although revived in 1894 by a new French Company, fell into abeyance for some years. Meantime the United States became involved with Spain, and

the Spanish-American war attracted their attention to the advantages of a canal wholly controlled by themselves.

The isolation of their ships on the Pacific coast, coupled with their obtaining a foothold in the Pacific by the acquisition of the Philippines, brought the desirability of an Isthmian canal into greater prominence.

Eventually the U. S. Government bought out the rights of the French company and obtained all that remained of their machinery and plant for £8,000,000.

By virtue of the Clayton-Bulwer Treaty of 1850, Great Britain possessed certain interests in an Isthmian Canal. After considerable diplomatic discussion our Government consented to tear up the Clayton-Bulwer Treaty and substituted a new one—the Hay-Pauncefote Treaty of 1901, whereby England renounced all her interests in return for a guaranteed neutrality of the Canal.

To obtain a fresh concession from the Columbian Republic—whose consent was essential—was the next step, especially as the U. S. A. desired absolute control of a strip of territory from sea to sea.

This Republic very naturally demanded a good price for so valuable a concession, namely, £5,000,000, but would not give away a square yard of their territory. However, without any apparent cause some provinces led by the province of Panama revolted from the Columbian Republic on 3rd November, 1903, and declared their independence. The steps taken by the Columbian Government against the recalcitrant provinces were ineffective and the revolutionaries triumphed.

The United States Government then negotiated with the infant republic of Panama for the purpose of acquiring a strip of territory ten miles wide from sea to sea, with virtual control of the towns of Colon and Panama, and the possession of four islands in the bay of Panama. For this the U. S. A. agreed to pay £2,000,000 down and a promised rental of £20,000 per annum for nine years.

The U. S. Government with a free hand were thus able to go ahead, but owing to many diversities of opinions in Congress not much could be done towards actually cutting the Canal. The first two years, therefore, *i.e.*, 1904-1905-1906, were devoted to sanitary measures and experimental work and exploration.

We now come to the construction of the Canal itself—the engineering aspect.

Fig. 2 shows in plan the proposed route of the Canal and the railway with re-alignment. In the case of the Suez Canal the land lying between the Mediterranean and Red Seas is very flat. Here between the Caribbean and Pacific the very reverse is the case. In going from Colon to Panama the ground surface varies in height considerably, rising up gradually to a height of 330 feet at Culebra for a stretch of eight or nine miles, and then dropping again more rapidly till the Pacific is reached.

If, therefore, a canal was to be cut at one level from sea to sea as in the case of the Suez Canal, an enormously broad and deep cutting 350-375 feet in depth would have to be made in getting through the divide at Culebra, over a stretch of eight or nine miles. (Figs. 4 and 5).

Fig. 3 shows a section made right across the Isthmus and gives a correct idea of this "Culebra Divide" that has to be cut through—but it must be remembered that the vertical scale is exaggerated.

Some engineers consider that this "all sea level" canal as it is termed, is quite feasible, but there are three grave objections to this.

In the first place it would cost an enormous amount of money to cut and secure such a mass of earth and rock—not less than £115,000,000.

Secondly, it would take several years to construct, and a very long time would elapse before the canal could be opened to earn any dues as interest on the capital expenditure.

Thirdly, there are also other objections, namely, the development of a tidal current due to the difference in tidal levels between Colon and Panama, where the tidal range is 2 feet and 20 feet respectively.

This would necessitate one lock at Gamboa at any rate, and also continuous dredging operations to keep the channel clear of fine mud and silt which would be carried in by the current.

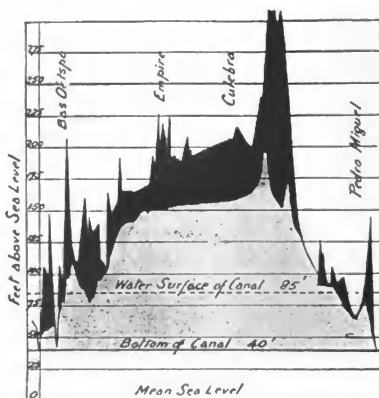


FIG. 3. LONGITUDINAL SECTION ALONG CANAL. THE BLACK AREA SIGNIFIES THE DEPTH REACHED BY THE FRENCH; THE SHADED AREA THE DEPTH OF THE CUT TO BE MADE BY THE AMERICANS

The alternative method of making the canal is to introduce "locks" at intervals. The effect of this would be to dam up the Rio Chagres and create a large lake—to be known as the Gatun Lake—with arms and indents of varying length as shown in Fig. 2.

The isthmus is subject to earthquakes and it is quite possible, though improbable, that the dams, lock gates and machinery may be greatly damaged by an earthquake, in which case the canal would be rendered useless until the damage had been made good; but to minimise the risk, the locks will be in duplicate, *i.e.*, twin locks. It is awful to contemplate what an appalling disaster would follow upon the bursting of the dam or "locks." With an "all sea level" canal it is claimed that this risk will be absent.

After considerable discussion the U. S. Government decided to excavate and construct an 85 foot level lock canal, *i.e.*, at a level of 85 feet above the sea for a part of its length, and reached by locks.

The plan of the Canal is briefly as follows:—

A 500 foot wide sea level channel, protected by a breakwater, will lead from Limon Bay, on the Atlantic, to Gatun, a distance of about eight miles.

At Gatun an enormous earthen dam, 115 feet high, will impound the waters of the Chagres River and form the Gatun Lake, 85 feet above sea level. Vessels will be raised to this level by three twin locks, *i.e.*, the 85 feet rise will be negotiated in three lifts.

Navigation will then proceed through the Gatun Lake for 23½ miles, when the Culebra Divide is reached; it is here that the great amount of excavation is being made.

The Culebra section of the canal from Bas Obispo on the N.W. to Pedro Miguel on the S.E. is 9½ miles long. Half a mile of it will be 500 feet wide at bottom; 4½ miles, 300 feet; and 4½ miles, 200 feet minimum width. The bottom will be 40 feet below M.S.L. and there will be 45 feet of water in the canal.

The Gatun Lake ends at Pedro Miguel where there will be another lock; the Canal then will run on for a short length of two miles to Miraflores, where vessels will go through locks in two "lifts" to sea level, and thence to Panama, making a total length of fifty miles.

Work has now been in hand upon this divide at Culebra, or as it is locally called the Culebra Cut, for about five years.

In Fig. 3 what is black indicates the amount of earthwork removed by the engineers of the French Canal Companies.

The light grained portion indicates what remained to be done when the Americans started work in 1904, before the canal is completed. It is estimated that it will take another four or five years to do this, but it is hardly likely to be opened before January, 1915.

By far the greatest amount of work to be done is located at Culebra, and the main engineering problem is the crossing, control and diversion of the Chagres River, which, moreover, has to be dammed up at Gatun. This large lake will serve an additional purpose in providing motive power for working the locks, etc., and for the transporting of mahogany and greenheart timber.

Excavation is done by machinery, by what are called steam shovels, many of which have been specially designed for the work. An excavating bucket or "dipper" on the end of a large lever arm scoops up the dirt, which by releasing a catch is let drop through a bottom door into trucks which are taken away to the "dump." This is a considerable improvement upon the French plant, but during the last two years much more powerful plant has been imported.

Long trains of "dirt cars" are conveyed along the Panama railroad and sidings to the various dumps and spoil banks. As far as possible the excavated earth is used to make dams and river diversions. In places the old channels of the River Chagres are being filled up, as the diversions and new channels are cut.

Elsewhere the dirt is rapidly removed by means of "rapid unloaders," quite modern plant and very effective and economical. These are manufactured by the Lidgerwood Company.

The French Company handed over a large amount of plant, machinery, locomotives, etc., to the U. S., but too small and light for the work to be done economically.

Much of the plant had to be abandoned in the jungle, and in so hot and damp a climate steel and iron rust rapidly and soon get destroyed. At one time locomotives were to be seen almost buried with creepers, with young trees growing in the tenders, and birds' nests. However, several of the locomotives

have been patched up and are in use, in fact, the Americans found many more serviceable than was estimated.

The work actually carried out by the French has hardly received adequate recognition. Their plans have proved very accurate and reliable, and their alignment well and correctly located; this is all the more remarkable considering the very adverse conditions of life that obtained in those days.

The great rainfall, risk of floods and landslides in such deep cuttings, especially in treacherous soil and loose rock, have added greatly to the engineering difficulties, and it is not uncommon for one of the steam shovellers to get flooded out in a few hours torrential rain, or overwhelmed by earth which requires days to remove before the machinery can be set to work again.

A word or two as to the defense of the Canal:—

The Pacific entrance to the Canal is much more picturesque than that in the Caribbean. There are some islands which have considerable strategic value and will in due course be fortified.

The latest proposals, so far as have appeared in the press, are as follows:

On the Pacific side:—

Batteries will be constructed on three of the fifteen islands in the bay of Panama, viz., Flamenco, Culebra, and Naos, supported by other batteries on shore.

A secondary battery will be built six miles inland to command the lock at Pedro Miguel.

A military post will be established at Culebra.

The most powerful batteries will be placed at the Pacific outlet.

On the Atlantic side it is proposed:—

To build batteries armed with guns on disappearing mountings, on the hills at El Bocho point. The smallest caliber will be 13-inch, the largest 16-inch. The estimated total cost is £1,500,000.

It may be of interest to note something as to the financial aspect and cost of the Canal with a few comparisons:—

1. The U. S. A. purchased:—
 - (a) The rights of the French Company for..... £ 8,000,000
 - (b) The "Canal Zone"—10 miles wide sea to sea, from the Republic of Panama for..... £ 2,000,000
 - (c) Rights of control for nine years at an annual rental £20,000 £ 180,000
2. Estimated cost:—
 - (a) Original, 1904 £27,000,000
 - (b) Amended, 1906 £40,000,000
 - (c) Revised, 1909 (all charges)..... £78,125,000
 - (d) Probable cost finished, under £90,000,000
3. Preliminary expenditure:—
 - Hygiene, sanitation and municipal improvements.... £ 2,750,000
4. Total expenditure to October, 1909, approximately.... £38,200,000
5. The Suez Canal cost to build £18,000,000
 - Manchester Ship Canal..... £15,000,000
 - Kiel Canal £ 8,000,000
 - Corinth Canal £ 1,000,000
6. There are some nine ship canals in the world and their aggregate construction cost was approximately £54,000,000, so that the Panama Canal will cost considerably more than the whole of the remaining ship canals in the world.

FIG. 4. CULEBRA CUT LOOKING SOUTH FROM CULEBRA.—FEBRUARY, 1908.



Journal of the Royal Artillery.

The Culebra Hill is the highest point on the Canal route, being 310 feet above sea-level. The cutting is the most formidable obstacle in the enterprise; but immense progress has already been made with the excavation, and if the present rate of work is maintained it is calculated that this section will be ready in a couple of year's time. The determining time factor in the completion of the Canal will not be the Culebra cut, but the Gatun dam and locks.

FIG. 5. CULEBRA CUT LOOKING NORTH FROM EMPIRE.—MARCH, 1908.



Journal of the Royal Artillery.

This view shows another part of the great trench through the rocky hills which separate the alluvial valleys of the Chagres and the Rio Grande. This section is nine miles in length, and the channel here will be 200 feet wide and 41 feet deep. More than half the work is already done, and the 100-ton American steam-shovels are reducing the 40,000,000 cubic yards still to be removed by some 2,000,000 every month.

7. As a further comparison:—*Three Panama Canals approximate in cost one South African War.*

The organization of the canal works is very complete. Every modern appliance and accessory has been installed. Electric light, telegraph and telephone installations, sterilized water supply, and every hygienic aid.

The dominant factor in the undertaking is administration by Government military engineers.

Military engineers of the U. S. army form the bulk of the Directing Staff, with Lieutenant-Colonel Goethals as engineer-in-chief, so that the whole undertaking is under good discipline and systematic organization.

Practically everything had to be created on the Isthmus; roads, railways, did workshops, power stations, reservoirs, etc. Although the French engineers a great deal the progress under the American engineers has been phenomenal. No private contracting firm would have embarked on the elaborate sanitary and hygienic measures carried out by the United States Government, nor would they have expended one-tenth the money that has been appropriated and well spent on municipal works. The United States of America are now reaping the benefit in a healthy staff and increased efficiency.

In addition there are the civil administration and sanitary departments of the Zone Government.

Time will not admit of my going into the organization and details of the several departments, viz:—

- | | |
|-------------------------------|-------------------------------------|
| 1. Panama railroad. | 5. Municipal construction. |
| 2. Excavation of Culebra Cut. | 6. Building construction. |
| 3. Dredging. | 7. Mechanical department. |
| 4. Locks and dams. | 8. Labor, quarters and subsistence. |

To take only one, viz., labor and quarters, as something has already been said about the other departments.

The Labor Department is charged with securing all labor, housing, supplies, and operation of hotels, messes, and kitchens.

Under a manager and assistant manager are divisional superintendents on the Isthmus, and six agents for recruiting; three are employed in the U. S. A., two in the West Indies, and one in Europe. The present head is a quartermaster of the rank of major in the United States army.

Labor is classified under three heads:—

1. Gold employees, *i.e.*, whites, American citizens.
2. Silver employees, *i.e.*, Alien whites, Spaniards, Italians, Greeks and the like.
3. Colored employees—negroes.

Quarters, hotels, messes and accessory buildings, are provided for each class.

The lowest salaried clerk who has established his home on the Isthmus is assigned an apartment consisting of bedroom, dining-room, sitting-room, kitchen, toilet, bath and lavatory. All quarters are completely furnished with the exception of linen, crockery, cutlery, and utensils; there is also provided fuel and sterilized water, all without charge. Most houses have electric light.

Quarters for colored married employees are also furnished without charge.

White single men, or "Gold Bachelors," as they are shown in the "Rolls," are usually housed two in a room 300 square feet floor area with all essentials including shower baths, electric light, and "janitor service," gratis.

White and black laborers, single men, are located in "camps," where there are commodious quarters and cots; the quarters and accessory buildings are well-maintained and healthy, with proper sanitary arrangements and water supply.

Twenty hotels are run for the accommodation of Gold employees and meal coupon books are issued on payment at reduced rates.

Twenty-five mess halls are in operation for the exclusive accommodation of the white alien laborers—Spaniards, Greeks, Italians, etc., and meal tickets are issued by the foreman.

Thirty-one kitchens are provided for the colored laborers. Common laborers are employed on a basis of compensation which includes subsistence, the department for which the laborer works being charged with the cost of his food. All accrued earnings are returned to the men in the way of extra food.

The number of employees runs into several thousands, being not far short of 38,000—equal to the strength of two divisions of British troops. There are approximately 6,500 gold employees; 24,000 silver employees, for whom over 1500 quarters exist, and several more are being built. The Canal Commission have also erected laundries, bakeries, schools, hospitals, ice factories, stores, clubs, and baths, etc.

Colonel Goethals the chief engineer has, therefore, a very fine and important "command," and the fact that since Congress placed the management and executive power in the hands of military engineers the progress has greatly exceeded the forecast, is an object lesson in the advantage of civil works of a *national* character being carried out under the supervision of Military Engineers.

STRATEGIC AND ECONOMIC CONSIDERATIONS

This now brings us to the consideration of the strategic and economic value of the Canal. Strategic, *i.e.*, the effect the Canal will have, in a military and naval sense, upon the U. S. A., the American Continent, and Europe, and how it will affect the "balance of power" between nations in the Pacific and Caribbean. By economic is meant the effect the Canal will have upon the commerce of the United States and the world in general, and in particular upon Central America. These two questions are somewhat interdependent and interwoven.

First of all it is desirable to observe the gradual development of the United States, which is the key to a correct appreciation why the Americans have been so anxious to get the canal built, and to bring the whole scheme under their absolute control.

The expansion and development of the United States has been westwards and southwards.

The earliest settlement (between 1585 and 1607) was Sir Walter Raleigh's colony of Virginia—so called after Queen Elizabeth, the "virgin queen."

Then Maryland, New England, Pennsylvania, Carolina (after King Charles II), and others. Thirteen in all were settled during the next 120 years, the last being Georgia, 1723, called after King George I.

These colonies constituted the original states which declared their independence in 1776 with a recognized constitution, and "united" in 1789 under the first President, George Washington.

Eventually, in 1750, Canada passed wholly under British rule and forms the prosperous Dominion of Canada to-day—a rival of the United States.

Louisiana was sold by the French in 1803. You will observe how the American nation has gradually extended across the Continent to the west until

the Pacific was reached. Subsequently they stretched out southward until they touched the Caribbean.

The interests of the United States are both political and commercial, that of Great Britain and other states mainly commercial.

Three centuries ago the general trend of British policy was westwards, but with the opening of the Suez Canal in 1869 it was directed more and more to the East Indies. In like manner American policy will veer more and more to the Pacific and China Seas, when the Panama Canal is cut.

Of recent years America has become a Colonial Power, having planted her flag in the Pacific, first in the Sandwich Islands, and after the Spanish American War, in the Philippines, Cuba, and Puerto Rico, for although Cuba is nominally independent, it is controlled by the U. S. Government.

The rapid development of the Pacific states and other states of the union has brought the foreign policy of America into greater prominence. When the United States took over the Philippines she stretched out a "white hand" over the Pacific—and the "sleeve" is the Panama Canal.

Now all the world has seen what Japan has done in the East, and how she intends to extend *her* influence throughout the Pacific.

The Americans do not intend to permit the Pacific to be dominated by Japan, nor will they passively allow the profitable markets there to be captured by the Japanese.

Therefore, to hold her own in the Pacific, America must create a large navy. This will be one of the most important results of the opening of the Panama Canal, even if it does not stimulate the increase in their fleet now, of which we have had evidence last year (1908).

The Canal will furnish the necessary short route to enable them to concentrate their fleet rapidly for operations either in the Atlantic, Caribbean, or Pacific.

From January to March, 1908, the Atlantic Fleet of the U. S. made a long cruise from Hampton Roads to San Francisco, a distance of 13,772 miles.

When the Panama Canal is cut this distance will be reduced to 5,300 miles, a saving of over 8,000 miles, in time, and also in fuel.

Let us look ahead ten or fifteen years; the Canal is cut. What effect can the entry into the Pacific of America as a sea power have on British interests? (*i.e.*, Greater Britain in the widest sense.)

Will the American Fleet preserve the equilibrium in that ocean or will it meet the fate of the Russian fleet at the hands of Japan? If so, what naval power will remain to challenge the predominance of Japan in the "peaceful ocean"?

What is there then to prevent Australian interests becoming subject to those of Japan? It is no idle question, for the nation that dominates the Pacific will be the "over-master" of Australasia, *i.e.*, the Pacific Continent.

Suppose the American fleet destroyed, the Philippines would become the stepping stones to the East Indian Archipelago.

Now about the "sleeve" through which the white hand has been thrust? Is it vulnerable, or is it not? The answer is decidedly yes. The very existence of the canal must in case of hostilities be a constant source of anxiety to the United States.

That Canal is a well-defined vulnerable strategic point, and unless the United States maintain a fleet in the Caribbean Sea, powerful enough to control the entrance or exit at Colon, and secure it against attack by an enemy, it may

become a source of weakness; if, for instance, it is known that the United States have any vessels in the Pacific trying to reach the Caribbean it is at Colon and only at Colon that their appearance need be anticipated. The same applies to Panama and vessels from the Caribbean. It follows, therefore, that unless paramount in the Caribbean by virtue of a powerful navy, the United States will not be able to control the Panama Canal.

As regards any strategic advantage to Great Britain, the Panama Canal will furnish little more than an alternative route to the Far East, in the event of the Mediterranean and Suez Canal being closed; but it can be shown by a comparison of distances* that the route from England *via* the Cape of Good Hope to points as far East as Melbourne and Sidney is quite as short as the route by the Panama Canal.

The position held by Great Britain in the West Indies has a considerable bearing upon the Canal. The only other Power besides the United States which has any predominating influence in the Caribbean is Great Britain, but this may not continue.

By virtue of her possessions there, viz., Jamaica, St. Lucia, Barbadoes, Trinidad, the Leeward Islands and British Guiana, she has so many bases and coaling stations for a British fleet.

It would appear very desirable, therefore, for her to hold tight on to what she has. *What Britain has let Britain hold!*

Other Powers may show increased sensitiveness as to the value of positions in the Caribbean, and strengthen their hold on any they already possess, and seek to acquire more.

Think of the possibility of Holland and her Colonies, in whole or in part passing into the hands of some Power hostile to Great Britain and American interests—to either or both—a Power possessing the ability to enforce her will on sea as well as on land to the disadvantage of others.

The Dutch colonies of Sumatra, Java, Borneo, and New Guinea, would confer immense advantage in the Pacific, and Guiana and Curacao would become bases for threatening these interests in the Caribbean.

The United States undoubtedly acquiesce in the present ownership of territories in the Caribbean and South America, but would probably seek to enforce or defend the Monroe doctrine should any European Power endeavor to obtain a foothold in the Caribbean or Pacific.

Summarized, the strategical aspect from the United States standpoint would appear to be as follows:

It is to America's interest:—

1. To promote and foster a cordial understanding with Great Britain as a powerful maritime neighbor already in possession of a splendid strategic center—Jamaica.
2. To prevent other powers obtaining a foothold or extending their influence in the Caribbean, either by force or barter.
3. To possess a navy adequate to assert their control in the Pacific and Caribbean.

In following some such policy there are great possibilities of political complication and trouble, and the United States may find their resources severely taxed in asserting their will. For instance, the United States Government will perforce have to control or, at any rate, concern herself with the relations of the Central American Republics, with Europe, and with one another involving an interference which they are not likely to appreciate.

* Vide appendix, page 329.

Moreover, to resort to force will be costly both in men, money, and material.

Recently, however, the United States have negotiated for transferring the more important obligations of some Central American Republics (Guatemala, Honduras, and Costa Rica) to the ledgers of Wall Street.

ECONOMIC CONSIDERATIONS

We may now pass on to a consideration of the effect of the Canal upon the commerce of the United States and the rest of the world. One matter which concerns the British West Indies may incidently be mentioned, namely, the employment of so many negroes on the canal works on the Isthmus; the ravages of climate will contribute to a considerable reduction in the populations of the West Indian Islands, and at the same time make labor scarce and dear, all of which may react unfavorably upon the prosperity of these Islands.

Now as regards the broad question. In the middle ages when Venice was a flourishing Republic, the world's commerce centered in the Mediterranean and Aegean, and continued there for some centuries until the discovery of the New World—the American Continent.

Thereafter the reputed wealth of Peru and the Spanish Colonies of South and Central America attracted commerce to the Caribbean, and the British, in common with other nations sought to participate in this wealth.

You may remember that the policy of Cromwell in the Caribbean was an aggressive one.

Jamaica was captured accidentally in 1657, and about that time Great Britain became the great sea carrier of commerce all over the world. At a later period when only 2% of our trade passed through the Mediterranean, no less than 25% came from the Caribbean.

But with the expansion of trade in the East Indies, *via* the Cape of Good Hope, trade with the West Indies began to wane; with the introduction following the opening of the Suez Canal, the Mediterranean once more came into the forefront of interest and became reinvested with some of its ancient pre-eminence.

It is possible that history may repeat itself when the Panama Canal is cut, and so induce a great increase of commercial activity in the Caribbean which, like the Red Sea, may become a great commercial thoroughfare. But it is by no means certain.

The greatest density of trade lies between Europe, Canada and North America, and Europe and the East Indies *via* the Suez Canal and Singapore. There is also a fair density of trade *via* the Cape of Good Hope to Australia, but the trade with the Pacific slope of South America is comparatively small. Now the opening of the Panama Canal is not likely to divert this trade, for there would be no saving in distance and the open sea is free of toll, whereas heavy dues must be charged on the Panama Canal to meet the interest on the vast capital expended.

As regards the Pacific trade, at the present time, America feels that, although she has a foothold in the Pacific, the Atlantic States are practically shut out from participation in the trade of the East, *i.e.*, in the North Pacific and China Seas.

American goods to reach the Pacific must either sail *via* the Cape of Good Hope, Cape Horn, or else be railed across the Continent, which is always an expensive matter. Hence the United States Government clearly appreciate the necessity of making a short cut from the Atlantic to the Pacific by cutting the Panama Canal.

When this is accomplished it will have the effect of figuratively transforming the route *via* the Straits of Magellan and Cape Horn to the Isthmus of Panama, just in the same way as the Suez Canal superseded the route to the East *via* the Cape of Good Hope.

The route round Cape Horn is storm swept whilst the Panama Canal will always be a fair weather passage.

Once provided with this shortened sea route the Atlantic States will be brought into closer touch with the Pacific States, which will enable America to become a keen commercial competitor and rival of Japan in the Pacific; this will tend to stimulate the shipbuilding industry in the United States.

"It is but natural that the United States should seek to the southward a firm commercial position if only to strengthen the Monroe doctrine.

"The danger of a European challenge of that doctrine is ever present so long as the chief creditors of the Central and South American Republics are European."*

A commercial center like New Orleans, Havana (Cuba), and Kingston (Jamaica), principal ports in the West Indies will undoubtedly benefit.

On the other hand, it must be borne in mind that the Panama Canal will always have very strong rivals in the Canadian and trans-continental railroads, and in the newly opened Tehuantepec Mexican Railway which will bid for a fair share of the New Orleans and San Francisco trade.

The Suez Canal, it should be noted, has never had, and will not have any rival route to the East until the Euphrates Valley Railway or some such overland communication is an accomplished fact.

Moreover, after being established some forty years, the Suez Canal—thanks to foresight and consideration by the Canal Commissioners—will be kept abreast of modern requirements, so that from the very date of opening of the Panama Canal as an ocean highway the Suez Canal will still be a superior waterway, capable of passing vessels of heavy tonnage and deep draught.

In this connection it may be interesting to note that vessels like the *Lusitania* and *Mauretania* have an 88 feet beam measurement and a draught of 36 feet; and we cannot suppose that the limit in tonnage, draught, and beam measurement has been reached.

The greater bulk of the world's trade, however, is *not* carried in large ships—Atlantic liners of great speed, like the *Lusitania* and *Mauretania*,—but in smaller craft—"ocean tramps," slow going cargo steamers—which call in all along the coasts of Africa and America collecting cargo at various ports.

It will not be to the interests of these trading vessels to forego their coast trade and make direct journeys *via* the Panama Canal unless they are carrying a perishable cargo of, say, fruit and meat for the speedy delivery of which the owners are willing to pay high canal dues.

There is, therefore, no very strong reason to lead us to believe that the Panama Canal will have any revolutionizing effect upon the world's commerce, though it is likely, however, to benefit American trade between the Atlantic and Pacific where, however, the United States will experience keen competition with China and Japan.

In conclusion it would appear that Great Britain, by maintaining a tight hold upon the fine strategic bases she possesses in Jamaica and the West Indies, can well afford to let the Americans defend their own interests in the Caribbean, whilst maintaining the cordial relations which exist between the United States

* Vide "American Foreign Policy."—*Times*, October 15, 1909.

and ourselves at the present moment, and see to it at the same time that no bond is weakened with "Britons over the seas," in any part of the Empire.

* * * * *

APPENDIX

Mileage Table (in round numbers).

	Via Cape Horn.	Via Cape of Good Hope.	Via Suez Canal.	Via Panama Canal.	Approx. saving on shortest ocean route, or via Suez.
NEW YORK.					
San Francisco.....	13,400	—	—	5,300	8,100
Yokohama.....	16,300	15,000	(13,000)	10,000	5,000
Melbourne.....	13,000	12,700	12,800	10,000	2,700
Hong Kong.....	17,200	13,600	11,600	11,600	nil.
Singapore.....	16,700	12,200	10,200	13,000	nil.
PLYMOUTH.					
San Francisco.....	13,500	—	—	7,800	5,700
Yokohama.....	16,600	14,300	11,000	12,700	nil.
Melbourne.....	13,200	11,900	10,700	12,600	nil.
Hong Kong.....	17,500	12,800	9,500	14,200	nil.
Singapore.....	17,000	11,400	8,000	15,500	nil.

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—*Journal of the Royal Artillery*, March, 1910.

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WIRELESS TELEPHONY.

(Adapted from the *Bulletin of the International Railway Congress* by 2nd Lieut.

A. H. Scott, R. E.)

I. INTRODUCTION

The term "wireless telephony" is generally taken to imply the method of transmitting speech by means of electric waves. The first wireless telephones transmitted speech by means of light waves, but as these two methods present a certain number of analogies, and moreover, the fundamental principles of wireless telephony by means of electric waves are closely related to those of telephony by means of light waves, it is interesting to glance at both methods. Graham Bell's photophone, invented in 1880, was the first attempt at light-wave telephony, and made use of the singular properties of selenium. It made telephonic communication possible over a distance of about 220 yards.

Ruhmer improved upon this, and succeeded in transmitting speech over a distance of about 9 miles. For his purpose, he made use of the properties of Simon's singing arc (*Fig. 1*). This device consists in superposing on the continuous feed current of an arc, the current induced in the secondary windings of a transformer by a microphone circuit connected with the primary. The microphone transformer can also be arranged on a branch at the terminals of the arc, by inserting a small auxiliary condenser. The arc faithfully reproduces any sounds produced in front of the microphone and acts like an excellent telephone receiver. This phenomenon is due to the fact that it responds to the smallest variations in the wave current in its circuit. These variations, which give rise to the sounds, are represented by corresponding variations in the temperature

of the arc and involve variations in the brilliancy of the light. The arc thus acts, not only as a telephone receiver, but also as a photophonic transmitter. It is merely necessary to place it in the focus of the mirror of a searchlight, and to direct the pencil of rays onto a similar one, having at its focus a selenium cell arranged in the circuit of a telephone, in order to obtain a reproduction of the words at the receiving station. This property of the arc is most important, as it forms the basis of a large number of devices which are used for telephonic transmissions by electric waves.

In the case of electric-wave telephony, the transmitter includes a microphone circuit, together with a source of emission, which generally consists of an oscillation circuit similar to those used in wireless (electric-wave) telegraphy, in connection with a tuned radiation system. Considering the transmission antennæ as a source of emission of the electric waves, which travel through intervening space in the same way as the light waves, it may be conceived that it is possible, just as in the case of light-wave telephony, to proceed in two different ways in order to make the sound affect the emission of the electric waves. These ways are:—(1). By modifying, by means of the microphone circuit, the

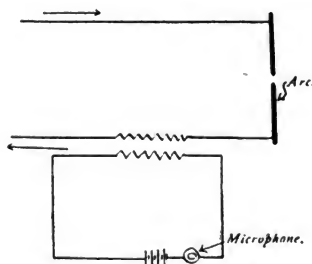


FIG. 1. SIMON'S SINGING ARC

intensity of the oscillations, their period remaining unchanged. (2). By keeping the intensity constant, and modifying the mutual reactions of the connected systems by the microphone circuit. This involves variations in the syntony of the apparatus. This plan can be very effective.

If conditions are arranged so as to be most favorable to selective effects, that is to say, if feeble damping is used, very slight alterations in the condition of resonance result in considerable modifications in the intensity of the effect received. Electric oscillations have a period which is not of the same order of magnitude as that of sound waves, and thus the sound waves cannot be made to act directly on the oscillations themselves. The electric oscillations succeeding one another with a certain rhythm give rise to wave trains; it is this rhythm which is capable of modifying the sound waves. In principle, the transmission is always affected by the undulations in the whole wave trains.

In constant-period transmission, this undulation results necessarily and directly from the variation in intensity of the waves sent out, *i.e.* from the variations in the intensity of the source. In constant-intensity transmission, it results from the variation in the number of wave trains acting on the receiver.

Although the number of wave-trains sent on may be invariable, these trains

may act in a different way on the receiver, they correspond to differently tuned waves.

II. THE RELATION BETWEEN WIRELESS TELEGRAPHY AND WIRELESS TELEPHONY

As soon as wireless telegraphy began, attempts were made to utilize its apparatus for transmitting speech. As long as only a coherer was available, *i.e.* a wave detector incapable of registering continual variations in the intensity, it was evident that there was no hope of obtaining any result. When auto-decohering detectors became available, attempts were first made to act on the spark itself by means of a microphone circuit. Later an attempt was made to obtain variations in the length of the spark by the rhythm of sound waves, by connecting one of the electrodes with a vibrating membrane, mechanically actuated by the microphone. All these devices were successively proposed and abandoned, the one definite obstacle to their application for the transmission of speech being the use of discontinuous and damped discharges for producing electric waves in the sending antenna.

In wireless telegraphy, whatever the device used, the discharges are obtained by connecting the balls of the oscillator with the secondary of an induction coil, or of a transformer excited by low frequency alternating current. The successive wave-trains are then always damped, and as a rule very far apart. This renders the use of devices on this system totally unsuitable for the purposes of telephonic communication.



FIG. 2. WAVE TRAINS

It is not on each individual wave-train, that the sound vibrations act, but on the trains as a whole. In order therefore that these modifications may convey differences of sound, it is above all necessary that they affect a sufficient number of trains.

To take a definite case, let it be assumed that it is required to transmit the standard note A, which has 435 vibrations per second. The series of trains sent out in a second must have 435 perturbations or beats, and this will evidently be only the case, if the number of trains sent out exceeds 1,000. Now, in the ordinary processes of emission by sparks, the number of trains sent out hardly exceeds 100 per second, and is often less. The phases of activity are thus interrupted by long intervals of rest.

Consider the emission of a wave of wave-length of 330 yards, which corresponds to oscillations with a period of one millionth of a second. Each train consists of about 20 oscillations, and therefore covers $1/50,000$ second. Assuming there are 100 per second, it is only after an interval that is 500 times longer, that a new train will succeed it. If one train in *Fig. 2* be represented by a length of 1 centimetre, the distance between two successive trains will be represented by a length of 5 metres. Notes of much higher pitch than the one chosen are often used, so it is at once evident, that, no matter how ingenious the arrangement of the microphone circuit, the method of excitation by sparks is hardly suitable for wireless telephony. The only way of obtaining any result is to modify the system of emission so as to increase the number of wave-trains. This has been done by the use of Duddell's arc, by means of which it is easy to obtain 20,000 and even 30,000 vibrations per second, *i.e.* to attain the limit of audible sound.

III. DUDELL'S ARC

Fig. 3 shows the practical adaption of this method, which is a development of the well-known phenomenon of the singing arc; the explanation is as follows: While the sound is produced by the singing arc, an alternating current is being produced in the condenser circuit. This current has the same frequency as the sound waves, and exercises an energetic inductive action on neighboring circuits. The primary of a transformer is fed by this current, which has a frequency that is already considerable in comparison with the alternating frequencies generally used, and discharges are obtained in the circuit of the secondary of the transformer, which succeed each other with the same rhythm, (that of the sound). In order to utilize this phenomenon, a condenser *C* and a self-induction *S*, which forms the primary of a transformer (without iron), whose secondary feeds the discharge circuit connected with the antenna, are arranged on a branch from the arc *A*. The secondary circuit includes a condenser *K*, and the primary turns of a tuned resonator on the antenna. The capacity of the condenser *K* is deter-

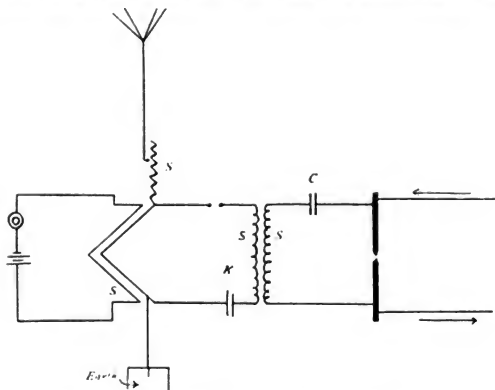


FIG. 3. UTILIZATION OF DUDELL'S ARC

mined by the condition, that it must be in tune with the secondary of the transformer *S*. The primary of *S* has only a few turns of wire and the condenser *C* is designed so that the note given by the arc is extremely shrill. The sound wave acts by means of a small coil with two windings, the primary forming part of a microphone circuit. The receiving circuit is the ordinary receiving circuit used in wireless telegraphy by sound.

IV. POULSEN'S METHOD

By means of Poulsen's method it is possible to multiply the number of trains sent out, and diminish the amount of blank space between the successive trains, till finally, instead of a discontinuous succession of damped discharges as are obtained in the case of sparking, a single and continuous wave-train is obtained. Poulsen has succeeded in increasing the rate of vibration of the singing arc from 30,000 to over 500,000 per second.

The principle of his method is to produce the arc in an atmosphere of hydrogen or of coal gas, and the phenomenon is the more readily produced if the cooling action of the hydrogen is assisted by an electric blow-out, *i.e.* by placing the arc between the poles of an electro-magnet. The arc should be fed with a high

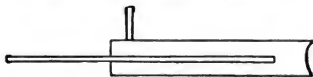


FIG. 4. METAL ELECTRODE, WATER COOLED

tension current of at least 400 to 500 volts. The arc must also have a certain "effective" length which increases with the current, and decreases with the frequency. The cooling of the electrodes is effected by placing them in hollow tubes, through which cold water is circulated. The best results are obtained if dissimilar electrodes are used, the anode consisting of a hollow copper tube having at its end a concave hemispherical wall (*Fig. 4*).

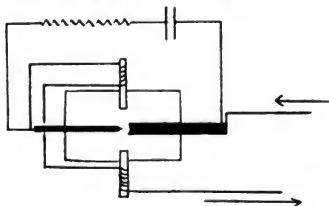


FIG. 5. POULSEN'S ARC

The effect of cooling the electrodes, and of the magnetic blow-out, is to make it possible to materially increase the intensity of the current in the arc, without stopping it from acting.

With the Duddell arc, the capacity of the condenser on the branch can scarcely fall below 1 microfarad; in this case, it can be given a much lower value. The production of the vibrations does not make a sound, the number of vibrations being far beyond the limit of audible sounds, but it can be made evident by the intense inductive action on neighboring circuits.

Figs. 5 and 6 show the principle of this method. The oscillation circuit should be arranged to contain a condenser and a self-induction. It should be arranged on a branch from the electrodes, and be connected to the antenna, either through some turns which form the primary of a Tesla, or by means of an Oudin resonator. It must be tuned to the antenna. The sound waves act by means of a microphone circuit, on a coil whose primary forms part of the feed circuit.

The receiving end consists of any suitable automatic decoherer, (generally electrolytic) which is on a tuned circuit on the receiving antenna, as in the case of wireless telegraphy (*Fig. 7*).

V. DE FOREST SYSTEM

In De Forest's system, the source of emission is a Poulsen arc, which instead of burning in hydrogen, burns in the gases produced by the burning of a spirit

lamp. The other difference, is that the microphone is placed at the bottom of the antenna, directly in series; this greatly improves the conditions of emission.

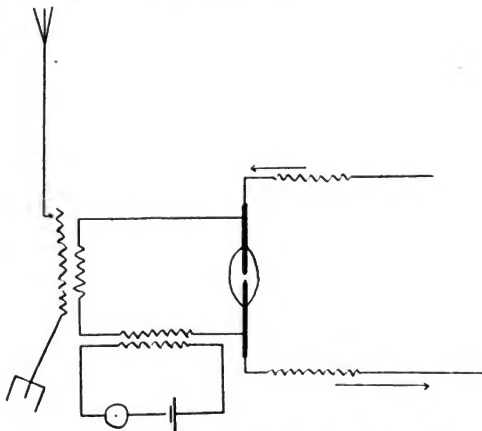


FIG. 6. TRANSMISSION OF SPEECH BY POULSEN'S ARC

The receiving circuit is shown in *Fig. 8*. Its main peculiarity is the audion (*Fig. 9*). This is an ionized gas detector, invented by De Forest, and based on

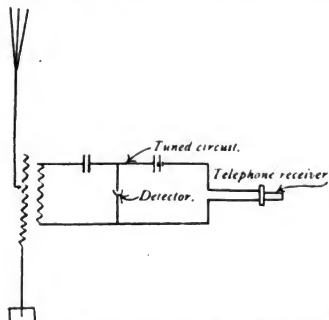


FIG. 7. RECEIVING CIRCUIT, POULSEN'S SYSTEM

the Edison effect. Edison discovered as far back as 1881, that if an extra auxiliary electrode is placed on the wall of an incandescent lamp, there is a current in a circuit connecting that electrode with one of the terminals of the lamp, preferably the negative terminal. This phenomenon has been explained by the

projection of a flow of negative particles escaping from the incandescent filament. This enables the audion to act as a valve, when it receives alternating oscillations, and thus it allows only the discharges of one sign to pass.

The trials of the De Forest instrument were so good, that the U.S.A. Government ordered it to be installed on all the vessels of Admiral Evans' fleet.

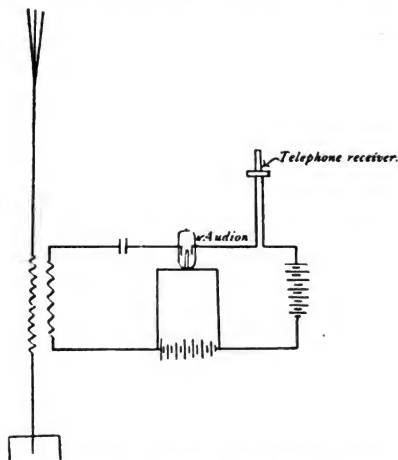


FIG. 8. RECEIVING CIRCUIT, DE FOREST'S SYSTEM



FIG. 9. DE FOREST'S AUDION

VI. THE REMAINING DIFFICULTIES

The principal difficulties in a wireless telephony system using an arc arise from the irregularity of the source itself. The arc produces a discontinuous succession of undamped wave-trains, rather than a single wave-train. Moreover, as a rule, not only is a single oscillation of one period produced, but a mixture of oscillations of different periods. The problem would be solved if instead of using an arc to produce the oscillations, some purely mechanical means were available, *i.e.* an alternator of high frequency. Many attempts have been made to produce these. Tesla and Elihu Thomson have constructed alternators giving a frequency of 10,000 to 15,000 periods. These machines consist in principle

of a slotted disc, with a large number of slots, revolving inside a ring of field poles. Centrifugal force makes it impossible however for these discs to revolve at over 10,000 revolutions per minute.

Duddell and Ruhmer have recently invented machines consisting of small discs from which they were able to obtain frequencies of 120,000 and 300,000 respectively, but unfortunately, these high frequency alternators only give a very low power (Duddell, 0.2 watt; Ruhmer, 0.001 watt).

Fessenden has an alternator, which, running at 139 revolutions per second, gives a frequency of 50,000 periods, and the power of which is 40 watts.

VII. PRESENT POSITION OF WIRELESS TELEPHONY.

Wireless telephony can now be said to have passed the laboratory stage and to have entered the domain of industrial application. The Poulsen arc system is much used. Poulsen has succeeded in obtaining telephonic communication over a distance of 105 miles; and the same distances have been obtained by officers of the French Navy in the course of experiments (Paris to Melun).

The record is at present held by the Italian Navy, as last November (1908) the torpedo boat *Lanciero* succeeded in exchanging messages firstly between Rome and Gaeta, (120 miles) and then between Rome and Caprera, a distance of 250 miles.—*The Royal Engineer's Journal*, April, 1910.



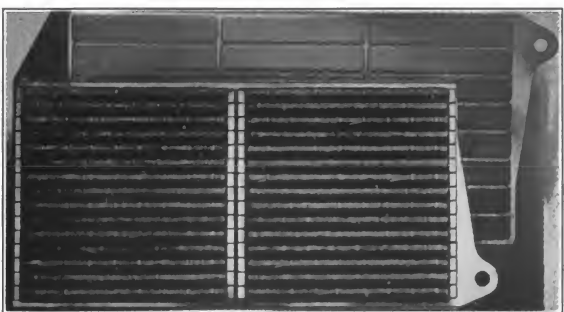
THE NEW EDISON STORAGE BATTERY.

The Edison Storage Battery Company, of Orange, N. J., announces the completion of the new Edison cell, which is now being placed on the market for traction service. In outward appearance it does not differ except in minor details from the original cell brought out in 1901, but the structure of the positive plate has been radically modified and other improvements embodied to increase the capacity and durability. At present the battery is made in two sizes; one size having four positive and five negative plates, and the other possessing six positive and seven negative plates. The active material in the positive plate consists of nickel oxide, and iron oxide is used in the negative electrode. The electrolyte consists of potassium hydrate (21 per cent. solution) to which has been added a small amount of lithium hydrate. The function of the lithium hydrate is not clearly defined, but it has been found to improve the working of the positive electrode. The normal specific gravity of the solution is 1.210, which does not change during charge or discharge. The efficiency and capacity of the cell, however, are not affected to any extent if the specific gravity of the solution is as low as 1.160. Below this a temporary effect is noticeable in the output of the cell.

The retaining cans are made of electroplated steel welded at the seams by the autogenous method—that is, by the application of the oxyacetylenic blow-pipe. The walls of the can are corrugated so as to obtain the greatest amount of strength with minimum weight. The iron element has an excess capacity over the nickel element. Much time has been spent in perfecting the latter. The original positive plate was made up of flat rectangular pockets containing nickel oxide and graphite. It was found that the graphite oxidized and that mechanically the structure could not resist the swelling action of the nickel oxide. In the new plate round tubes 4 in. long and about the diameter of an ordinary pencil are used to retain the nickel oxide. The tube is made of thin perforated



CELL PARTLY OUT
OF CASE.



POSITIVE AND NEGATIVE PLATES



TOP VIEW OF CELL.

steel, which when filled with the active material and properly bound by eight steel rings, makes expansion of the active material impossible and insures perfect internal contact. Instead of the graphite formerly employed, electrochemically prepared flakes of pure nickel are interspersed in the oxide to increase the conductivity of the active mass, because nickel oxide of itself is a poor conductor. Each positive plate consists of a grid of nickel-plated steel holding 30 of these tubes. The negative plate comprises 24 flat rectangular pockets supported in three horizontal rows in a nickel-plated grid. The pockets are made of thin nickel-plated steel perforated with fine holes, each pocket being filled with an oxide of iron and afterward subjected to very heavy pressure.

The plates of each group are hung on a connecting rod perpendicular to, but tegral with, the pole. They are held apart by nickel-plated steel washers and held in contact by nuts screwed on both ends. The two outside plates are negative and are insulated from the retaining can by sheets of hard rubber. Hard-rubber pieces are also fixed between the can and the side and bottom edges of the plates, and these, together with the hard-rubber rods inserted between the plates, maintain correct spacing and insure permanent insulation.

The cover of the cell, which is also welded in place, has four mountings. Two of these are for stuffing boxes through which the positive and negative poles extend; one is a separator which prevents the loss of electrolyte while allowing the gases to escape, and the other is an opening for water and electrolyte.

This opening is fitted with a water-tight cap held in place by a catch. Fastened to the cap is a spring so arranged that the cap will fly open unless properly fastened. In an assembled battery each individual cell is held securely in place and from contact with adjacent cells by a small hard-rubber button which extends through the slot on each side of the tray and fits over an emboss pressed out on the side of the can. The bottom of the cells are held in position by small buttons protruding from a conveniently arranged wooden block fastened to the bottom slats of the tray. The indentations in the bottom of the cell fit over these buttons. A rubber apron insulates the cell from the block.

The separator through which the gases escape while the battery is charging is designed in such a way that these escape in a substantially dry condition, the globules of liquid coalescing with a liquid film which forms at the base of the casing and the seat of the ball valve with which the battery is fitted, and in this way falling back into the cell. The electrolyte, therefore, need only be replenished with distilled water until completely changed in every eight or 10 months.

Electrical connections between the cells are made by heavy copper connectors, well plated with nickel. The lugs at the end fit over taper-joint binding posts and are held in place with a nut. A socket wrench for removing the nuts which hold down the connectors and a specially designed jack for lifting the lugs from the binding pots when disconnecting the cells are sent with each battery. The trays in which the cells are assembled are very light, and where formerly the ends and the bottom were dovetailed together, the trays are now made of continuous strips, the corners being bent. The data of the cells are given herewith:

	Type A-4	Type A-6
Normal ampere-hour output	150	225
Average discharge voltage per cell	1.2	1.2
Normal rates of charge and discharge in amperes	30	45

	Type A-4	Type A-6
Weights (in pounds) of cell complete	13.5	19.2
Width of can	3 $\frac{7}{8}$	3 $\frac{1}{2}$
Breadth of can	5	5
Height of can	13 $\frac{1}{2}$	12 $\frac{3}{4}$
Height of cell to top of pole (not assembled)	13 $\frac{1}{4}$	13 $\frac{1}{4}$
Required height of battery compartment	15	15

While the normal rate of charge of the smaller cell, for instance, is 30 amperes, charging may be done at double this rate for a one-hour boost if the temperature is kept from rising much above 100° F. It is also permissible, though not recommended, to discharge a battery continuously at rates up to 25 per cent. above normal, and for occasional short intervals of time, as in hill climbing or starting on heavy roads, no harm is said to result if the rate be increased to three or four times normal. The capacity of the Edison battery increases after being in service, so that when working some time the efficiency is increased and greater output obtains also. This process of self-forming continues over a period of from one to three months of regular service, and it is partly to assist in this forming up that the overcharges are recommended at intervals.

The battery possesses reserve capacity. The highest practical limit of output is reached when a battery is charged 10 hours at the normal rate, and its value will be, for a fully formed battery, perhaps 30 per cent. more than the rated output. A seven-hour charge at normal rate is considered a normal charge. With a rated discharge three times normal the voltage drops 0.03 volt for every 10-ampere increase. On returning to normal discharge the voltage comes up to a value a trifle higher than normal owing to the heat generated at the heavy discharge rate. Heat on discharge increases the output, while heat on charge diminishes it; but excessive heating at all times impairs the life of the battery. The watt-hour efficiency ranges from 60 per cent. to 65 per cent. The smaller battery gives about 14 watt-hr. per pound of cell, and the larger cell 16 watt-hr. According to the makers, the battery cannot be injured by overcharging; it does not deteriorate when left discharged; any cell can be removed simply by detaching the connections from the poles, and the battery has nearly twice the output or mileage of other batteries weight for weight.

To test the performance of this battery in traction service a set consisting of 200 of the smaller cells, with 10 separate cells for lighting, was mounted on a new type of light-weight car, designed especially to minimize "dead weight" and get a maximum of useful service, was tried out on the lines of different railways in and around New York.

The car is capable of seating 26 passengers, and is 18 ft. between corner post and 26 ft. over all.

The various weights are as follows:

Carbody	3,500 lbs
Truck and electrical equipment	3,500 "
Batteries	3,000 "
26 passenger load	3,750 "
Total weight of loaded car	13,750 lbs

The motors are wound for 110 volts and rated at 5 h.p. each at a speed corresponding to a maximum of 15 miles per hour.

The batteries are placed under the seats, and lighting is by means of eight 10-c.p. 12-volt tungsten lamps.

The control arrangement is as follows:

1st step; batteries in multiple at 50 volts, motors in series.
 2d step; batteries in multiple at 100 volts, motors in series.
 3d step; batteries in series at 100 volts, motors in multiple.

No fixed resistances are used, the control being entirely as shown.

The power consumption of this car when accelerating at 1 mile per h.p. is said to be about $3\frac{1}{2}$ kw., and when running about $1\frac{1}{2}$ kw.

The tests have been satisfactory in every way, and cars so equipped would have a field of their own in operating long-branch lines of infrequent service, as well as in many other ways.—*The Electrical Age*, February, 1910.

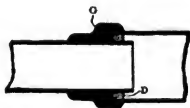


A NEW SYSTEM OF LEAD JOINTING

A new process for the jointing of lead in pipe or other form, the invention of T. Harden, late of the British Insulated and Helsby Cables, Ltd., is being introduced by the Metal Jointing Company, Ltd., (Adelphi House, 71 Strand, London, W. C., England), says *Electrical Engineering*.

The lead surfaces to be joined are cleaned in the usual way and a thin sheet of specially prepared tin is inserted between them. The joint is then heated with a blowlamp, and the melting of the tin causes the lead surfaces on either side of it to melt at a lower temperature than the normal melting point of lead. An actual weld is thus formed between the two surfaces to be joined.

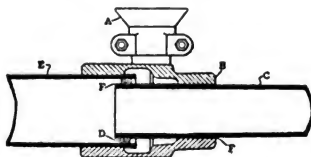
The tin strip for this purpose is supplied by the company under the name of "Amalgaline," and consists of a ribbon of pure tin 0.05 millimeter in thickness, treated with a patent composition to prevent the formation of oxides during heating. In the case of a joint in an ordinary lead-covered cable, after the conductors have been jointed and insulated, the lead sleeve is drawn over the joint, a strip of "Amalgaline" is wrapped round the lead covering of the cable at each end, and the sleeve is dressed down to this. Sufficient heat is then applied to the outside of the sleeve over the "Amalgaline", and the joint is complete.



FINISHED END OF SLEEVE

In telephone, telegraph, and other large dry-core cables, it is not always desirable to dress down the heavy lead used for sleeves, and so for such work a mold is used as illustrated in the accompanying figure. The sleeve is passed along the cable in the usual way before the conductors are jointed and the jointing is proceeded with; when completed, the sleeve is scraped clean inside for a short distance, the outer surface of the lead of the cable being similarly treated. A piece of "Amalgaline" is placed on the cleaned part in the interior of the sleeve, and another piece, *F*, is wrapped round the lead sheathing of the cable. The sleeve, *E*, is then drawn into position, and a piece of ordinary engine packing, *D*, is driven between the cable and the sleeve. The mold, *B*, is then placed in position and molten lead poured in. An important feature is

that the mold is so constructed that the hot metal runs direct from the pouring gate to the space beneath the cable, and then wells up round the cable, so that there is no risk of the lead being burned through by the metal being poured direct on to it. The time for plumbing a large telephone cable is said to be reduced by about thirty minutes.



METHOD OF CASTING END

The system is also advocated for making tee joints in lead-covered cables, and the company has already supplied a number of small house-service boxes made entirely of lead. These are divided in the usual way, but require no packing. When the joint is complete, "Amalgaline" is placed between the flanges and round the cables where they enter the box, and the whole heated up and welded water-tight. Of course, no supplementary bonding is required.

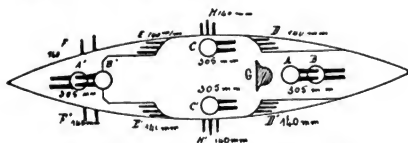
We understand that a large number of sleeve joints have been made by this process by the Fulham (London, Eng.) Electricity Department, and that during a period of over two years they have in no single instance needed the slightest attention.—*Electrical Review & Western Electrician*, April 23, 1910.



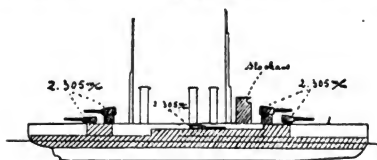
THE NEW FRENCH BATTLESHIPS

The new 23,000-ton battleships have the following characteristics, according to *La Vie Maritime*: Length between perpendicular 165 m.; maximum beam at water-line 27 m.; maximum draft aft 9 m.; displacement 23,467 metric tons. Armament: Twelve 12-inch in six turrets, four on the middle line and one on each beam; twenty-two 5.5-inch (new model) in two armored casemates; four 47 mm. on the forward bridge; four under-water torpedo-tubes, one forward and one aft on each side. Freeboard forward about 7 m. Height of 12-inch guns from 11.5 m. for the forward pair to 6.5 m. for the aftermost pair. Height of 5.5-inch guns 5.8 m. average for 18 central guns, 3.6 m. for four after guns. The 12-inch projectiles are 4 calibers long and weigh 970 pounds; those of 5.5-inch caliber weigh 81 pounds. The turrets are of English model, central loading. Designed horse-power 28,000; speed 20 knots; turbine machinery; large tube boilers; coal at normal displacement 900 tons; full bunkers 2700 tons; three smoke-stacks instead of five, as on the *Danton*. Magazines refrigerated. Ten 90-cm. projectors. Conning-tower of new design, containing range-finding and indicating instruments, a compartment for fire-control officer and compartments for the admiral and his staff and for the captain and his assistants. A complete main armor belt 27 cm. thick at the middle and 18 cm. thick at the ends, extending 2.35 m. above and 2.50 m. below the normal water-line; below it another belt 18 cm. thick protecting the bases of the turrets.

and stocks. Two armored decks, one 48 mm. and the other 70 mm. thick. The 5.5-inch guns behind 18 cm. armor. The conning-tower 12 inches thick on front and sides.—U. S. Naval Institute, March 19, 1910.



AA', BB' 12" turrets having an arc of fire of 90° .
CC', DD' 10" turrets having an arc of fire of 180° .
EE', FF' 5.5" guns in turrets having an arc of fire of 150° .
G Conning tower.



THE 23,000-TON BATTLESHIPS



NAVAL CHRONICLE (BRITISH)

ARE DREADNOUGHTS TOO LARGE ?

In the course of his address at the Institute of Naval Architects, Admiral Bacon discussed some important points in connection with the size of Dreadnoughts. The chief argument against their size is the enormous cost, and, therefore, the large loss in case of sinking. Another argument was that our harbors are already too small, and that our docks require enlarging, while the ships had become too large to handle in fleets. As to the first of these arguments, Admiral Bacon pointed out that the whole crux of the question lay in the consideration as to whether a large ship or a small ship is more likely to be lost from the attack of a torpedo. Constructionally there seems to be no doubt that the larger the ship the more likely she is to survive the blow of a torpedo. This is Admiral Bacon's view, but, as he says, surviving is not the sole point. Damage by torpedo will incapacitate a ship, however large she may be, but, on the other hand, the small ship may sink and so the loss of a fighting appliance would become permanent. The question, therefore, resolves itself into one of repair, and Admiral Bacon maintained that provided the number of ships is kept constant, although their size is increased, no danger to the country accrues by the building of larger ships. It is purely a question of finance.

"SMALLER SHIP" DANGERS

Many naval men have expressed themselves strongly in favor of a larger number of smaller ships, with a less number of large ships, their contention

being that the money would be better spent upon numbers than upon size. Admiral Bacon, in his address to the Naval architects, favored the large ship. In the small ship, he pointed out, speed, size of gun, and power of each hit are sacrificed; in addition to which the length of the line of battle is considerably increased. The fewer the guns mounted in each ship, the larger the number of ships which will be required for an equal number of guns. Therefore the larger number of intervals between the ships and an equivalent increase in the length of the fighting line. When the increased range of the torpedo is remembered this is an important consideration. Admiral Bacon believes that there is an important future before the torpedo as a Naval weapon of offence. If the range can be brought up to 6,000 yards it has great possibilities in an action. There is no doubt that it is far easier to hit one of twelve ships with a torpedo than to hit a single ship aimed at, so that the longer the line of ships, and the greater their numbers, the more vulnerable they will be to attack by destroyers at long range in action. In Admiral Bacon's opinion this is, therefore, an additional argument in favor of the larger ship rather than an increased number of smaller ones.

GUN *versus* ARMOR

The contest between gun and armor which has been going on for half a century has, for the moment, been decided in favor of the gun, and, in Admiral Bacon's opinion, there is no indication of there being a chance of improving the armor and strengthening the general construction of a ship so as to render it reasonably immune from armor-piercing projectiles. The guns of the present day can penetrate at about six thousand yards any armor which can be practically mounted on a ship, and guns can be built which could penetrate this armor at ranges outside which it would be practically impossible to bring a fleet action to a definite conclusion. In Admiral Bacon's opinion, however, the armor-piercing projectile is not the most efficient shell for effecting general damage on a ship. Penetration of armor is not, he points out, the sole object of gun-fire. The chief damage will probably be done by heavy bursting charges, the heavier the bursting charge the greater the damage inflicted by each individual hit, so that, from this point of view, the larger the gun and the larger the projectile the better. But if the gun is to be increased in size something must be sacrificed, either speed or armor, or the number of guns must be reduced. Admiral Bacon suggests armor.

NAVY BATTLE PRACTICE

Last Years Record

The Admiralty issued on Tuesday a White Paper containing the results of the battle practice of the Fleet during the year 1909. The Admiralty state that the conditions of practice differed little from those in the previous year, and it was satisfactory to note an improvement in the results obtained. This is the supreme test of the firing of our Fleets during the naval year. It is, therefore, all the more satisfactory to know that the general efficiency in the opinion of the Admiralty has been well maintained.

The China Fleet comes first in order of merit, with an average of 348.68 points; the First Division of the Home Fleet and the First Cruiser Squadron are second with 293.63 points; the Mediterranean Sixth Cruiser Squadron third, with 195.56 points; the Third Division of the Home Fleet fourth, with 187.5 points; the Second Division of the Home Fleet and the Second Cruiser Squadron fifth, with 177.76 points; and the Atlantic and Fifth Cruiser Squadrons sixth,

with 142.17 points. The total number of ships firing was 72, using 983 guns, making 216.78 points. In 1908, 63 ships took part, using 890 guns, making 203.44 points, the average for last year was 13.34 better than in 1908.

Of the ships in the China Fleet, the armored cruiser *King Alfred* (flagship of Vice-Admiral the Hon. Sir Hedworth Lambton) was at the top of the list, and the *Bedford* second, the points being 510.4 and 312.5 respectively. The First Division of the Home Fleet and First Cruiser Squadron had the *Boadicea* at the top, with 541.66 points, and the *Bellerophon* and *Dreadnought* tying for second place, with 450 points. The Mediterranean Fleet and Sixth Cruiser Squadron, third in order of merit, had the *Canopus* at the top, with 459.82 points, and the *Suffolk* second, with 267.85 points. Of the Third Division of the Home Fleet, firing with nucleus crews in the same conditions as fully-manned ships, the *Sutlej* was at the head of the list, with 443.75 points, or only about 65 points less than the top ship of all, while the *Carnarvon*, second ship, made 383.92 points, or more than the total of the second ship of the First Squadron in order of merit. The first ship of the Second Division of the Home Fleet and Second Cruiser Squadron was the *Warrior*, with 320.31 points, and the *Africa* second with 279.76 points. The *Argyll* was leading ship of the Atlantic Fleet and Fifth Cruiser Squadron, with 401.78 points, and the *Drake* second, with 312.5 points.

The ships in Australia fired at a fixed target, and the *Pyramus* was best, with 406.25 points, and the *Psyche* second, with 343.75, the average for that Fleet being 275.42. The ships on the Cape of Good Hope station fired in the same circumstances, and the *Forte* was best, with 325 points, and the *Hermes* second, with 294.12, the average for the Fleet being 262.93. For those two Fleets the average for last year was 82.34 points better than 1908. The scouts fired at two targets, and the *Foresight* led, with 357.1 points, while of the gun-boats, which fired at a towed target, the *Spanker* came first, with 104.1 points, and the *Leda* second, with 41.7.

Remarkable Figures—Uneven Shooting

No comparison is made in the return with the practice of individual ships in former years, but the figures show a remarkable unevenness in firing by ships of the same fleet. This is important, because a high average is of more value for war purposes than two or three instances of crack shooting. How uneven was the firing the battleships and armored cruisers of the Second Division of the Home Fleet will show. Here are the figures:—*Warrior*, 320; *Africa*, 279; *Shannon*, 276; *Cochrane*, 273; *Dominion*, 247; *Britannia*, 241; *Hibernia*, 181; *New Zealand*, 137; *Commonwealth*, 86; *Hindustan*, 62; *King Edward VII.*, 44.

The first four ships of the *King Edward* class in the fleet scored between them 948 points; the last four ships, though of identically the same type, scored only 329 points.

What the Dreadnoughts Did

It is interesting to note the points made with the 12-inch guns by which the Dreadnoughts in the First Division of the Home Fleet are armed. They are as follows:—*Bellerophon* and *Dreadnought*, 450 points each; *Superb*, 400 points (ten guns each); *Indomitable* (8 guns) 375 points. Of the other battleships of this Fleet, the *Agamemnon* made 348.21 and the *Lord Nelson* (her sister ship) 133.92. These two ships are armed with four 12-inch and ten 9.2-inch guns. The battleship *Bulwark* and armored cruiser *Minotaur* tied

with 178.57 points. The battleship *Irresistible* 169.64 and the armored cruiser *Defence* 285.71. The average for the fleet 293.63. The shooting of the Mediterranean Fleet was also very uneven, the battleship *Canopus*, which was first ship of the Fleet, making an average of 459.82, and the battleship *Duncan* at the bottom of the Mediterranean list only averaging 44.64. The flagship *Ezmouth's* average was 223.21.

In the Atlantic Fleet, the same feature is observable. The armored cruiser *Argyle*, the top ship averaging 401.78, whereas the battleship *Queen's* record is only 26.78 and that of the battleship *Formidable* 62.5. The range of scores in the Third Division of the Home Fleet is from 443.75 for the armored cruiser *Sulej* to 13.39 for the battleships *Mars* and *Magnificent*.

—*Hampshire Telegraph*, March 26, 1910.

BATTLESHIP ARMAMENTS

Apropos of the power of the 12-inch gun, it is as well to bear in mind that what tacticians ask for is not so much penetrating power as great bursting charge. The damage done by one well placed shot from a 12-inch gun, having a great bursting charge, would be far greater than mere penetration of armor, and far more destructive than any number of 6-inch shots driven home in the same period. The all-big-gun principle of armament is, therefore, not at all likely to be replaced by a mixed armament, in spite of all the advocates of secondary batteries may urge. The simultaneous flight of the various sized shots would, many gunnery experts argue, militate against accurate spotting or gun control. For that reason alone it is maintained that a *Dreadnought*, with her 12-inch guns, could secure a greater number of hits in a given time than a *King Edward*, which has three types of guns. But the whole subject of bursting charges has been under consideration by the Admiralty, and recent experiments have, it is said, fully convinced the responsible officers of the vast destruction which shell explosion on board is capable of doing. That the Admiralty should adhere to their disposition of the guns for the later *Dreadnoughts* (with only a little variation) may be accepted as proof that the gunnery experts have far more practical experience in this respect than the Naval officers of any other Power, including Germany. Tests have been carried out for the British Navy which have been wanting in the others.

—*Hampshire Telegraph*, March 16, 1910.



THE BALLISTIC DEPARTMENT OF THE MILITARY TECHNICAL ACADEMY AT BERLIN

The Ballistic Department of the Military Technical Academy in Berlin, has some very interesting apparatus. This department includes chemistry and ballistics proper. The work in both courses is practical.

For general chemistry, a very well equipped, light, laboratory is provided. Special rooms, sound proof and arranged to obviate danger, are provided for tests with explosives. Of interest are the apparatus for measuring the temperature of explosion and that for indicating the force of explosion with a time coordinate. The latter is described in the *JOURNAL OF THE U. S. ARTILLERY*, May-June and July-August, 1909, in an article entitled "Measurement of the Pressure of High Explosives by Considering the Elapsed Time from Ignition to Complete Volatilization of the Explosive," translated from the German,

originally published in the *Zeitschrift fuer das Gesamte Schiess-und Sprengstoffwesen*. Another single means of measuring the comparative force of explosions, also used in the experimental work at this school, is a lead block with a hole in it. The explosion according to its force makes a smaller or larger balloon-shaped cavity (see sketch).



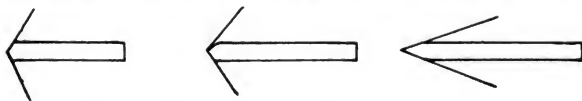
BEFORE EXPLOSION



AFTER EXPLOSION

In the ballistic section, practical experimental work is carried on. Ballistic formulae and tables are used as a means to reach conclusions from the observed results of experiments—evidently an improvement on text-book instruction in the class room. Among the interesting instruments used here are: 1. Bou-lange chronograph, which is considered the best all-round apparatus for measuring velocities; 2. Condensator method, see *Mitteilungen ueber Gegenstaende des Artillerie-und Geniewesen* (Austria), 1902; 3. Optische Gewehr Ruecklaufmesser, see *Zeitschrift fuer das Gesamte Schiess-und Sprengstoffwesen*, November, 1909; 4. Ballistische Kinematograph, see same periodical for January 3, 15, February 1, and September 1, 1909; 5. Comparator, devised at the Academy to measure the photographic coordinates.

Of the above instruments special attention is called to the Optische Gewehr-ruecklaufmesser and the Ballistische Kinematograph. By means of the latter instrument, sharp photographs of the projectile in flight are taken. The projectile passes between a source of light produced by an arc and a parabolic reflector and a revolving film, the speed of which is known. The speed of this film and the arrangement of the arc flash are such that 3 or 4 good photographs of the projectile are taken as it passes. An ingenious method of making the circuit is to have the bullet pass through a candle flame, blowing it into the break and closing the circuit and causing discharges from a Leyden jar across the arc space before the reflector. The apparatus is installed in an indoor gallery, which can be made dark; the experiments are generally with small arms, but artillery projectiles to 3-inch can be fired also. By means of these photographs the velocities may be determined; but the most useful application of the instrument is in connection with the study of the shape of the head and its influence on the resistance offered by the air. The displacement of the air is clearly shown in the photographs. The angle of displacement is much smaller for the pointed projectile than for the round-headed one. Thus:



By means of the kinematograph, the automatic movements of the parts of an arm and the appearance of the gases at the muzzle can be closely studied. For example, experiments were made with rifles and automatic pistols. Photographs of these firings were taken and afterwards thrown on a screen by a

kinetoscope, the movement of parts being made as slow as desired. Any defects in functioning could be observed,—the explosion of any gas from the breech; or the appearance of gas at the muzzle before the bullet, showing defective seating. Thus this instrument has been of great use to proving boards.

Further references are: *Die Verwendung des parabolischen Scheinwerfers bei der elektrischen Momentphotographie*.—*Kriegstechnische Zeitschrift*, XIII Jahrgang, 2d and 3d Heft.

Short Notes

Testing the Portsmouth Boom Defence.—An important test has been made of the new harbor-defence boom at Portsmouth, England. The obstruction consisted of 120 large baulks of timber, each about 40 feet long and 12 inches square, with sharpened steel spikes at their outer ends and bound together with heavy iron chains and steel-wire hawsers. The Laird-built torpedo-boat destroyer *Ferret*, 16 years old, of 290 tons, of nearly the same size and displacement as the American torpedo-boats *Bailey* and *Farragut*, was used in the experiment, the object of which was to ascertain whether the boom was strong enough to prevent the entrance of torpedo craft into the inner harbor at Portsmouth. The destroyer, which is 194 feet long, with 19 feet beam, was specially strengthened for the attack, by means of steel plates, and the bows were made sharp. A volunteer crew was on board. Although the boom was constructed scientifically and according to the best British practice, the *Ferret*, traveling at 15 knots speed, experienced no difficulty in steaming through the obstruction. Her sharpened bows slashed the chains and hawsers, and the destroyer proceeded without apparent loss of speed into the inner harbor, where the royal dock-yard and the Whale Island gunnery school are situated. The immediate result of this experiment involves a reconsideration of the whole question of boom defences for British harbors. The test is, in a way, the most important of its kind made in the British Navy in nearly a quarter of a century. The new Portsmouth boom is similar to the one at Sheerness. The baulks each weigh a ton, and special launching slips with strong stationary engines are used to place them in position. There are spikes not only along the outer ends of each baulk, but also at regular intervals along their sides. These are intended to pierce the bottom of any destroyer or torpedo boat attempting to jump the boom. The *Ferret* did not try this method, but headed her course between the baulks, and her bows cut the cables with ease.

Before the experiment, doubt was entertained if a destroyer of this type would be able to pass through the boom. It was, in fact, said prior to the test, that naval officers at Portsmouth believed the obstruction would withstand the shock and that it would be shown that similar booms could be successfully used for the protection of entrances to commercial harbors now undefended or protected with nothing more than light armaments. In any war in which Great Britain might be engaged involving British waters as its theatre of action, such harbors would certainly be raided with torpedo craft, hence the importance of the efforts being put forth for the strengthening of British harbor and port defence.

Preceding the *Ferret* experiment, the defences of Portsmouth were subjected to a night attack. The boom was placed in position at the entrance to

the harbor and held there, while all traffic in and out of the harbor was suspended. The fortifications were manned by the Royal Garrison Artillery, with searchlights, and the Portsmouth Reserve Flotilla contributed half a dozen destroyers and torpedo boats for the attack. This was the first night attack since the completion of the new outer breakwater which compels all vessels to enter the roadstead *via* the deep channel, which is well protected by the forts. Before this breakwater was built, torpedo craft were able to creep along where the water was shallow and thus elude the vigilance of the forts. As the six torpedo vessels could not do this in the night attack, they were soon detected, and the vessels were theoretically put out of action.

—*The Navy*, April, 1910.

Speed Trial of the Italian Battleship Napoli.—The new first-class battleship *Napoli*, at her three hours' full speed trial, made an average of 22.5 knots, with the engines developing 19,700 i. h. p., and making 122 revolutions; she has a displacement of 12,500 tons, and steam is provided by 22 Babcock and Wilcox water-tube boilers. The new first-class battleship *Roma* has also completed her trials successfully; at her three hours' full speed-trial she averaged 22-knots, with her engines developing 21,000 i.h.p., steam being supplied by 18 Babcock and Wilcox water-tube boilers. The new first-class armored cruiser *Pisa* and a sister-ship of the *Pisa*, the *Amalfi*, have also successfully completed their trials.—*Page's Weekly*, January 28, 1910.

French Submersible Archimede.—A submersible displacing 577 tons is France's latest, known as the *Archimede*. She attained 15½ knots on the surface during her recent trial. This vessel has a large radius of action, and can steam from Cherbourg to Toulon, or Bizerta, without refueling. The accommodation for officers and men permits each of the officers to have a cabin, while there are good messing arrangements and plenty of elbow room for petty officers and men. She has electrical cooking apparatus. The *Archimede* has been over three years building. Such a vessel as this should be able to cruise with a squadron as freely as destroyers.—*Army and Navy Journal*, April 2, 1910.

Launch of the Austrian Battleship Zrinyi.—The launch of the Austrian warship *Zrinyi* took place at Trieste on April 12. This is the last of a group of three ships having a displacement of 14,226 tons and carrying four 12-inch guns and eight 9.4-inch, all of .45 calibers. They are not Dreadnoughts, but mark a further stage in the advance of the Austro-Hungarian navy toward the goal of first class efficiency. A strong propaganda is on foot for naval expansion, and many agencies are at work to stimulate public opinion. In Austria the cry is against Italy, and the plea that Austria must become the dominating naval Power in the Adriatic. No doubt the position of Italy in the Triple Alliance makes the application of this stimulus somewhat difficult, but the "Dervishes," as the scaremongers are called, are employing it. In this connection the *Army and Navy Gazette*, London, notes that "while the Austrians are talking about Dreadnoughts the Italians have begun to build them, and before the end of the year four will be in hand, ships of a new type entirely. The first of the series, the *Dante Alighieri*, will have twelve 12-inch guns, but the three others will carry no less than thirteen guns of the caliber. Ahead and astern fire may be to some extent sacrificed in favor of a powerful broadside. The guns of the *Dante* will be in double turrets on the center line, as in the United States ships, but in the other ships there will be triple turrets forward and abaft, and it is said

another amidships between the funnels, and two double turrets firing over the triple turrets. This arrangement would give a fire ahead and astern of five guns and of thirteen guns on either broadside. The conception is very daring, and if it can be carried out will make the Italian ships the most powerful yet built or laid down. Whatever may be the possibilities of ahead and astern fire, the present tendency is to concentrate attention on the broadside discharge. Thus it is pretty well known that the new Russian ships will have their twelve guns all mounted in triple barbettes on the middle line."

—*Army and Navy Journal*, May 7, 1910.

U. S. Torpedoboot Destroyer Reid.—A speed of 41.4 miles per hour for four hours was made last week by the U. S. torpedo boat destroyer *Reid* over a trial course off the Florida coast of the Gulf of Mexico. This 36-knot speed is the record for any naval vessel. A board of naval inspectors is now engaged in an inspection test of the five boats of this class which are about to be commissioned. All of the boats maintained high speeds, especially the *Flusser*, which made 35-knots over the four-hour trip, but the *Reid* showed about a knot better speed than the best of the others.

In our issue of Oct. 14, 1909, p. 400, we reported the first speed test of the *Reid* when she made 34.548-knot speed over a measured mile. Just before that (Sep. 16, 1909, p. 313) we reported that the *Flusser* had made 33.7-knots over a measured mile. When made each of these were record speeds. These boats are 295 ft. long and have a tonnage of 700 tons.

—*Engineering News*, April 14, 1910.

The first German Dreadnoughts.—As a class, the first German Dreadnoughts seem to be universally unlucky. In the beginning they were delayed considerably because their designers could not find out all they wanted about the British prototype. Then the designed draught is somewhat exceeded. The *Nassau* sank in dock, and was considerably delayed by this; the *Westfalen* failed to leave her builders works at the first attempt, and nearly came to grief by stranding in the river on her way down to a dockyard; and now the third vessel, the *Posen*, has been seriously damaged by fire. The *Rheinland* is to be commissioned at the end of this month.—*The Engineer*, April 8, 1910.

Armament of Italian Battleships.—Latest accounts give the armament of the Italian battleship *Dante Alighieri* as ten 12-inch guns, and of the *Conte di Cavour*, *Giulio Cesare* and *Leonardo da Vinci* as thirteen 12-inch. In each design there is a triple turret forward and aft with a twin turret superposed, while the three later ships have also a triple turret amidships. All the turrets are on the center line.—*The United Service Magazine*, April, 1910.

Reorganization of the Portuguese Navy.—The *Seculo* gives some details of the proposed reorganization of the Portuguese Navy. A new arsenal is to be built on the Tagus, opposite Lisbon, and several cruisers, torpedo craft, and submarines are to be bought. It is stated that the Portuguese Government is in communication with Yarrow and with Armstrong, Whitworth, with regard to the construction both of the arsenal and of the ships.

—*The United Service Magazine*, April, 1910.

Chilian Naval Programme.—The new Chilian programme comprises one battleship of 23,000 tons, six 28-knot destroyers of 900-1000 tons, a mine-layer, a hospital ship, and two submarines.

—*The United Service Magazine*, April, 1910.

French Aerial Cruiser.—The French War Minister has put aside a sum of 5000 francs (£200) as a prize to the author of a type of aerial cruiser, with a promise of future orders, if the type is adopted. The following are the conditions: 1. Rate of speed, 50 kilometres the hour; 2. Possibility of remaining stationary in the air for 15 consecutive minutes; 3. To carry at least a crew of 6; 4. Height of ascension 2000 metres; 5. Capacity not to exceed 6500 cubic metres; 6. Dimensions: length, 70 metres; height, 20 metres; diameter, 13 metres.

The airship should be able to accomplish a circular voyage of 500 kilometres in 15 hours, with 7 metres a second; two-thirds of the voyage must be carried out at a height of at least 1300 metres.

—*The United Service Magazine*, April, 1910.

The Maxim Biplane.—The first details to be published of the aeroplane invented and made by Sir Hiram Maxim have been communicated by him to the "*Evening Standard and St. James's Gazette*." The machine, which is a biplane, 44 ft. between the extreme points of the planes, is at present at the Vickers, Maxim works at Crayford, near Dartford, Kent. The four-cylinder 80-h. p. engine—which is Sir Hiram's own design—weighs 220 lb., and its carburettor furnishes a supply of gas of correct and uniform density. The engine petrol tank and driver are grouped at an unusually low point in the machine, as the inventor's theory is that the center of gravity should be much below the lifting parts. Two passengers, as well as the driver, can be carried. There are three screws and three rudders. There are horizontal rudders fore and aft and a vertical rudder, all of the balanced type. The framework of the planes is of American wood, covered by a specially treated silk, of which 250 sq. yds. have been used. The struts or braces in the machine are partly of light steel oval tubing and partly of American pine, also oval in shape. An interesting feature of the preliminary trials is the fact that wires, running from a steel mast 130 ft. high, will be attached to the aeroplane, so that the flights will be captive ones.—*Page's Weekly*, February 25, 1910.

The Zeppelin III.—One of the reasons why the German War Ministry refused to accept the Zeppelin III. as a military airship, states a contemporary, is that the weight of its aluminium framework was nearly six tons. That airship is now to be practically rebuilt, and instead of aluminium the new alloy elektron is to be used. Elektron is an alloy of aluminium and magnesium, of which the specific gravity is 1.7, whereas that of aluminium is 2.6. It is also found that elektron can stand greater stress than aluminium, and that by using elektron instead of aluminium a reduction can be made of about 50 per cent. in the weight of the airship.—*The Engineer*, January 21, 1910.

Gyroscope Appliance for Aeroplanes.—A French engineer, M. Redgnar, has devised a gyroscope appliance for aeroplanes, which has, says the Paris correspondent of the *Daily Telegraph*, been brought to the notice of the Academy of Science, and which, it is thought, may prove of great utility in increasing the safety of aeroplanes in flight. The gyroscope is so contrived that by means of an electric combination the wings will be warped, and the other steadying devices so adjusted at the slightest change of the air resistance that the aeroplane will dart along with automatic stability. It appears that the weight of the machine will not thereby be materially increased, and it will be very interesting to note the results in practical experiments.—*The Engineer*, April 1, 1910.

A Speed of 131.7 miles per hour over a measured mile was attained by an automobile of 200 H.P., on the beach at Daytona, Fla., on March 16. This exceeds the speed record attained by any other method of transportation.

—*Engineering News*, March 31, 1910.

Automobile Maneuvers.—This year maneuvers of volunteer motorists will commence on the 11th May from Dresden, and will be carried out for two and a half days, as far as Vienna. German, Austrian and Saxon volunteer motor corps will take part in them; the Hungarian Corps was obliged to abandon participation owing to the lack of a sufficient number of cars. The scheme of the maneuvers has been elaborated by the German and Austrian staff, but nothing is known of its details. No doubt the tactical ideas will remain secret, as on previous similar occasions.—*The United Service Magazine*, April, 1910.

A Motor Searchlight for Army Use.—The *London Electrician Review* in a recent issue gives some particulars of a new electrical searchlight outfit mounted on an automobile chassis, which has been made by a Paris firm for the French army. The machine, in addition to a thirty-four-inch projector, and the necessary electrical generator, has accommodation for five men, including the driver. It can attain a speed of sixteen miles per hour, and is also adapted to travel across country, for transporting the searchlight.

—*Electrician Review and Western Electrician*, March 19, 1910.

The Automatic Rifle.—The honor of being the first nation to arm its troops with an automatic rifle can be claimed by Mexico, where one designed by General Mondragon is about to be adopted. It is of the gas-operated type, and its tests, which have been carried out with considerable severity, have failed to detect any flaw. The Mexican troops were formerly armed with a Mauser, and as the cartridge of this latter gave satisfactory ballistic results it has been retained for its successor. This plan has obvious advantages, and removes many of the difficulties of rearmament, as the new rifles can be issued as finances permit without the danger of providing two sorts of small arm ammunition. Further, improvements suggested by experience can be carried out without calling in a large quantity of weapons and leaving a percentage of units unarmed.

—*Army and Navy Gazette*, April 16, 1910.

Tungsten filaments are commonly made by mixing the metal in a paste that is then extruded in the form of a filament, after which the paste is expelled and the particles of metal are welded together by an electric current. This complicated method of forming the filaments is due to the fact that tungsten is not sufficiently ductile to be drawn out into fine filaments. An English concern has just discovered a method of producing drawn filaments of tungsten, and the General Electric Company has also just announced the discovery of a method by which tungsten may be rendered sufficiently ductile to permit of its being drawn into fine wires. The drawn tungsten filament is stronger than the filament made by the "sintering" process.—*Scientific American*, April 23, 1910.

Platinum-Iridium Hot-Wire Ammeters and Voltmeters.—A hot-wire voltmeter was the earliest form of switchboard voltmeter for use on alternating-current circuits. This was the Cardew voltmeter. It consisted essentially of a tube containing some 4 m. of fine platinum wire in two loops. The ends of this length of fine wire were connected to a pair of terminals receiving the full main pressure of, say, 120 volts. The heating of the wire by the current, under the impressed e. m. f., expanded and lengthened the wire slightly,

while a pointer, moving over a nearly uniform scale of volts, indicated by means of this expansion. The Cardew voltmeter was for some years the most generally used switchboard alternating-current voltmeter, but finally gave way before smaller and more compact instruments of lesser temperature error. After some time a new form of hot-wire instrument made its appearance on switchboards, for current as well as for voltage. In this form, a short length of wire was used, but its expansion under load was magnified considerably before being delivered to the pointer wheel. These instruments were dead-beat; in fact, they were apt to be rather sluggish, a quality sometimes advantageous in switchboard work. Their principal objection has been temperature error. They have to work with their wires well below red heat, and then any incidental charge of, say, 20 deg. C. in their surroundings was likely to affect their readings very distinctly. A recent number of the *Elektrotechnische Zeitschrift*, as alluded to in the *Digest*, describes an improved form of these hot-wire instruments. Platinum-iridium is the substance employed for the fine wires and their working temperature is raised. At the same time, the base of the instrument is of such metals as enables a compensation for external temperatures to be automatically maintained.

—*Electrical World*, April 28, 1910.

Tantalum for incandescent lamp filaments, according to "Mineral Resources of the United States" for 1908, published by the Geological Survey, is imported into the United States from Germany at a cost of about \$300 per pound. More than 20,000 filaments, of 20 c.p. each, can be made from one pound of tantalum.—*Engineering News*, April 7, 1910.

Magnetic Declination.—Observations made in 1908 and 1909 by the U. S. Coast and Geodetic Survey in all parts of the country show no radical difference in the annual change from those published in the "Magnetic Tables" for 1905.

—*Engineering Record*, April 23, 1910.

A *Wireless telegraphy station* near Berlin claims to have established a record in combined overland and sea transmission of wireless messages. The station recently succeeded in maintaining wireless communication with a Woermann liner during the entire voyage from Hamburg to the Cameroons. The greatest distance signalled was 6600 kiloms.(over 4000 miles). Although messages had to pass over the Alps, the Algerian tableland, and the Adamana Range, communication was, it is stated, effected with astonishing ease.

—*The Engineer*, April 8, 1910.

French Military Libraries.—The French Government has recently sanctioned an allowance of £4 a year to each of fifty-five artillery regimental institutions for the purpose of purchasing professional books. In addition to this, the subscriptions to the principal military magazines are defrayed by the State, and we are glad to know that in several cases these include the *Army and Navy Gazette*. Maps are supplied free. The French evidently consider that they have a considerable percentage of men in the ranks who will appreciate and understand technical literature. In our own regimental libraries the scanty funds are often expended on popular novels, and standard military works are rarely to be seen. A grant for the purpose of purchasing military literature would be much appreciated, and would well repay the small expenditure involved.—*Army and Navy Gazette*, April 9, 1910.

Effects of Deforestation on Floods and Droughts.—The good old days when every subject from protoplasm to postmasters was settled around the Tennis Court and all who differed one jot or tittle from the kitchen cabinet were assigned to the Ananias Club are proved conclusively to have disappeared by the publication of the report of the U. S. Weather Bureau on the effect of deforestation on floods and droughts. The report was prepared by direction of the Committee of Agriculture of the House of Representatives, and gives the results of investigations lasting several years. In it we are told that floods are no more frequent than formerly and of no longer duration. The evidence is said to be strong that the cutting down of forests has had something to do with creating or augmenting droughts, and that precipitation controls forestation, while forestation has little or no effect on precipitation. Spring floods are asserted to come more often from forests than from the open. The publication of this report, contradicting so completely some of the documents of the Forest Bureau, is note-worthy.—*Engineering Record*, January 22, 1910.

NOTICES

An exposition of industry, manufacture, art and agriculture will be held at Odessa, Russia, from May 15 to October 1, this year, under the auspices of the Odessan branch of the Royal Russian Technical Association and the Royal Agricultural Association of South Russia.

Russian and foreign exhibits will be displayed.

The following will be found among the exhibits:—Products of fibre, wood, metal and mine, sculpture, painting, airships, commerce, hygiene, farming, machinery, forestry, irrigation and live stock.

The space for exhibitors in the scientific department will be allotted gratuitously.

In order to make up for the lack of copies of D. R. C. A., the Commanding Officer of the 94th Co., C. A. C., has had printed in pamphlet form the parts of the D. R. which refer to formation of the company, drills, firings, etc. One copy is issued to each man and enough are on hand to supply the reserve company during the annual encampment. This seems to be an excellent idea.

New Advertisers

We take pleasure in inviting attention to the following advertisements, appearing for the first time in this issue of the JOURNAL. We bespeak for them the consideration of our readers:

Colgate & Company, New York.

U. S. Cavalry Association, Fort Leavenworth, Kansas.

Goodenough & Woglom Company, New York.

Man's Magazine, Wilkes-Barre, Pa.

CORRESPONDENCE

Any communication received by the Editor, which the writer desires inserted, which is signed by him and which would be of interest to the readers of the JOURNAL from a military point of view, will be published in this department. It is especially desired to have questions asked and small items of information given. Questions asked in one issue will be answered in the next, where possible, by some person, or persons, who is considered to be capable of giving authoritative information on the subject involved. Answers or remarks, regarding any such question by any others will always be very welcome. The readers of the JOURNAL (and all others interested in it or its work) are most cordially invited to make full use of this department.

Fort Wadsworth, N. Y., May 8, 1910.

The Editor,
Journal U. S. Artillery,
Fort Monroe, Virginia.

Dear Sir:—

I take pleasure in calling the attention of artillery officers, both regulars and reserves, to a publication entitled "The Service of Coast Artillery", the authors of which are Captain F. T. Hines, of the regular Coast Artillery, and Major F. W. Ward, of the Coast Artillery Reserves of New York.

I have carefully examined this book and consider that it is one of the most valuable publications for a coast artillery officer that has ever been published. It contains in a single volume, and in convenient form, all the information that has been published from time to time in orders, circulars, memoranda, pamphlets, artillery notes, and bulletins. The plates are by far the best that have ever been published.

Details of the instruments, guns, carriages, etc., are clearly shown and the names of the various parts are on the plates.

Inasmuch as a large part of our artillery equipment has now become standardized, it has been practicable for a publication of this kind to become of permanent value.

Without a desire to in detail call attention to the many subjects treated, I would say in general, from my examination, that it contains about everything that an officer needs to refer to in his daily work at a modern coast artillery post or in his study of the theory of the science of coast artillery. The authors are to be congratulated in having produced a book that is of real value to the service.

Very respectfully,
W. G. HAAN,
Major, Coast Artillery Corps,
U. S. Army.

Fort H. G. Wright, N.Y., May 8, 1910.

The Editor,
Journal U. S. Artillery,
Fort Monroe, Virginia.

Dear Sir:—

I am enclosing some notes on instruction of Militia, Coast Artillery, which I prepared primarily for the use of the Connecticut Coast Artillery. The scheme enables the officers to prepare themselves without having access to "Service of Coast Artillery" (Hines-Ward), which they did not have during the period of instruction.

As far as I have been able to learn, examinations so far have been held only in the District of Boston. The general policy, I believe, will be and should be to defer the examinations until the militia officers shall have had the benefit of practical instruction during their summer encampments.

With kindest regards, I am

Very sincerely,

W. E. ELLIS,

Major, Coast Artillery Corps.

NOTES ON FIRST YEAR'S COURSE, COAST ARTILLERY CORPS,
ORGANIZED MILITIA, AS PRESCRIBED BY PAR. 10, S. O. 227,
DEPARTMENT OF THE EAST, 1909.

Each officer should have access to the following:

Drill Regulations for Coast Artillery. [D. R. C. A.]

General Orders, War Department. [G. O.] Circular 13, War Department, 1910.

Coast Artillery Memoranda, War Department. [C. A. M.]

Ordnance pamphlet descriptive of gun and carriage to which company is assigned. [O. P. gun, and O. P. car.]

Gunner's Instruction, 6th Edition. [G. I.] Published at Fort Monroe, Va. Rates: 1 copy 25 cents; 25 copies, \$5.00 dollars; 50 copies, \$7.50. Address Journal U. S. Artillery, Fort Monroe, Va.

1. Service of the piece:

(a) Duties of each member of the gun and ammunition section under all conditions. [D. R. C. A., according to assignment to armament.]

2. Gun and carriage:

(a) Nomenclature, purpose and action of the several parts. [O. P. gun and O. P. car.]

(b) Packing stuffing boxes and cleaning recoil cylinders. [G. I. p. 36; D. R. C. A., par. 869 (according to type of carriage), and pars. 870 and 871.]

(c) Adjustments of

Quadrant elevation device. [C. A. M., No. 6, 1910, (c) page 4, and (1) page 7.]

Sight standard. [D. R. C. A., par. 526.]

Throttling valve. [C. A. M. No. 6, 1909 (h), page 6; G. I., page 37.]

Gas check pad. [D. R. C. A., 873.]

Elevating gear. [C. A. M. No. 6, 1909, (e) page 5; Circular 13, War Department, 1910.]

Grease cups. [G. I., page 39, and O. P. car.]

Firing mechanism. [G. I. page 39, and O. P. gun.] (Note—Officers may find some difficulty in obtaining a clear idea of the detail of this mechanism

from description and plates. Each officer should make it a special point to familiarize himself with this mechanism during his first visit to a coast fort.)

(d) Care and preservation. [D. R. C. A., Chapter XVIII. (Omit pars. 869, 870, 871, 873, and 890. Gun companies also omit pars. 863 to 869 inclusive.)]

3. Powders, projectiles, primers, fuzes:

(a) Ventilation of magazines.

A magazine should be closed as much as possible during the winter, but during other seasons of the year should be ventilated freely on clear dry days, when the temperature of the outside air is below that of the magazine. The dryest weather usually obtains when the wind is from the south-west around to north-west. When thus opened, the hours for ventilation should extend from about three hours after sunrise until about one hour before sundown. Magazines should always be kept closed during fogs, rains, or easterly gales.

(b) Blending powder and preparation of charges. [C. A. M. No. 1, 1910.]

(c) Filling and fuzing projectiles. Explosive D is generally used as a filler. In this case projectiles are filled by the Ordnance Department prior to issue. With explosive D, base detonating fuzes are used, the mechanism of which is confidential. No. 6, "medium caliber" is used in all steel projectiles from 2.97 to 7 in. caliber inclusive. No. 10, "Major caliber" is used for all steel projectiles for 8", 10", and 12" guns and mortars.

For powder charged shell of all calibers from 2.95 to 12 in., inclusive, a centrifugal, base percussion fuze is used. (The mechanism of this fuze is not confidential. The details may be studied from the "fuze board", issued by the Ordnance Department.)

In order to fill a shell with black rifle powder, proceed as follows:

"Unscrew and remove the plug from the shell. Place the filling rod in the bag and fold the latter around the rod; insert it through the plug-hole, taking care to not force the end of the rod through the bottom of the bag; carefully push in the bag until the neck only is in the plug-hole, a portion being kept outside, as the whole bag must not be allowed to slip into the shell during the operation of filling; then withdraw the rod and insert the funnel in the neck of the bag, pressing the funnel well down into the plug-hole; pass the filling rod through the funnel and gradually pour in a small quantity of powder (say about half of the charge); take out the funnel and rod, lift up the bag and jerk it so as to "set" the powder well down to the bottom and to open the bag; then reinsert the rod and funnel, as before, and continue the filling; choke the bag and cut off the superfluous choke. The filling rod should be moved up and down while pouring in the powder, to facilitate its passage through the funnel, the powder in the shell being tamped on at the same time. The use of a large mallet against the side of the shell (any piece of wood will answer the same purpose) will materially assist in getting the maximum amount of powder into the shell.

"When the shell is quite full withdraw the funnel and filling rod, and tie the neck of the bag with two hitches of twine close to the top of the plug-hole. Cut off the superfluous choke, and push the neck of the bag well down the plug-hole into the shell, then screw in the plug as required.

"Lead rings are supplied for the armor piercing shell. The ring is hammered into the recess around the head of the plug, and the superfluous metal removed.

"No preparation of the bag by pricking or otherwise is necessary."
[Clove's Gunner's Examiner, 1906.]

In order to make a tight joint rubberine paint is placed in the fuze hole, and

on the threads of the fuze, and the latter is screwed up tight. The inside of a shell should be carefully coated with lacquer or varnish, before being filled.

(d) Painting of the projectiles. [G. I. page 40.]

(e) Care of empty cartridge cases and primer bodies. [G. O. 5, War Department, 1910, par. 4, (m), and par. 14.]

Cordage, gins, shears, jacks, and their use. [G. I., pages 42 to 46.]

A long splice is made as follows:

"Unlay the ends of two ropes to a distance of two or three times greater than for a short splice, and place them within one another as for a short splice. Unlay one strand for a considerable distance and fill up the interval which it leaves with the opposite strand from the other rope. Twist the ends of these two together, then do the same with two other strands. The two remaining strands are twisted together in the place where they were first crossed. Open the two last named strands, divide in two, take an overhand knot with the opposite halves, and lead the ends over the next strand, and through the second as the whole strands were passed for the short splice. Cut off the other two halves. Do the same with the others that are placed together, dividing, knotting, and passing them in the same manner. Before cutting off any of the half strands, the rope should be well gotten upon a stretch. Sometimes the whole strands are knotted, then divided, and the half strands passed as above described. This splice does not increase the diameter of the rope, and it is used for splicing the fall or other rope that runs through blocks." [Cloke's Gunner's Examiner, 1906.]

The running part of a tackle is the running part between sheaves; the standing part, that between fasts and sheaves; and the fall, the part held in hauling.

A whip is a rope through a single block. A gun tackle is a rope passed through two single blocks and made fast to one. A luff is a rope passed through a single and double block, and made fast to the single block.

Experiments made at Fort H. G. Wright, N. Y., shows that, with two treble blocks, power gained was $4\frac{1}{2}$, and with two double blocks, $3\frac{1}{2}$.

From these experiments the following table of power gained is deduced for making adjustments:

Combination.	Power gained.
Two treble blocks	$4\frac{1}{2}$
Treble and double, treble movable	4
Treble and double, double movable	$3\frac{1}{2}$
Two double blocks	$3\frac{1}{2}$
Double and single, double movable	3
Double and single, single movable	$2\frac{1}{2}$
Two single blocks, movable block moving towards fall	$2\frac{1}{2}$
Two single blocks, movable block moving against fall	2
Whip with moving block	$1\frac{1}{2}$

[Circular No. 1, Artillery District of New London, January 11, 1910.]

5. Camp Hygiene. [G. O. 44, War Department, 1908, paragraphs 103 to 115, inclusive.]

BOOK REVIEWS

The Service of Coast Artillery. By Captain F. T. Hines, C. A. C., and Major Franklin W. Ward, C. A. C., N. Y. New York: Goodenough & Wogolom Company, 122 Nassau Street. Cloth. 6¼ x 9¼. 563 + vii pp. 91 illustrations & 41 plates. Price, \$3.50 net.

For many years there has been an urgent need of a work, which should give the everyday information needed by anyone in the coast artillery service. Tidball's Manual of Heavy Artillery answered admirably in the old days, but the time is long past when it was of more than occasional use in the work of the coast artilleryman. The kaleidoscopic changes which have been going on in our work for a dozen years have rendered the preparation of any sort of a complete up-to-date treatise impossible. Now, however, we seem to have settled down to make the most of our present system. "The Service of Coast Artillery" is, therefore, published at a very opportune time. It is really a monumental work, covering all branches of the broad field of modern coast artillery.

Chapter I gives a very complete glossary of technical terms. The fact that this chapter covers sixty-two pages suggests the breadth of its scope.

Theory and principles of coast defense, forms of attack from the sea, the "run-by", landings; plan of land defense, field combat, night attacks are the subjects covered in Chapter II.

Chapter III takes up the Organization and Personnel of the Coast Artillery Corps.

Gunnery and Ballistics is the heading of Chapter IV. The construction of the built-up gun and its breech mechanism are clearly explained and shown by diagram. Rifling, powder and the phenomena of explosion, the trajectory, aiming and laying, accuracy of fire and the elementary formulas of ballistics—make up one of the best chapters in the book. The explanations given of these subjects are, taken all in all, the clearest and best for the purpose of which the writer has information.

Chapter V treats of our modern system of built-up guns and their carriages—the 16-inch, 14-inch, all models of 12-inch, 10-inch, 8-inch and 12-inch mortar—these of the primary armament; the 6-inch, 5-inch and 4.7-inch of the intermediate and the different types of 3-inch and 2.24-inch of the secondary armament. The firing mechanism, gas check pads, sub-caliber guns and detailed description of all types of carriages complete this chapter.

Explosives, projectiles, fuzes and primers are described in Chapter VI. Excellent cuts show the details of each of them.

Chapter VII is headed "Instruments, Devices and Charts." Under this caption the following are described with cuts of each: Depression position finders (Warner and Swasey, and the new Lewis), azimuth instrument, engineers' transit, the gun, mortar and submarine mine plotting boards, range and deflection boards, wind-component indicator, aeroscope, telautograph, tele-

phone, thermometer and barometer, anemometer, atmosphere board, all models of sights used in our service, the gunner's quadrant, crusher gage, time-range board and searchlights.

Submarine mines and their accessories, including small boats are treated in Chapter IX. Work in the loading room, the casemate and on the water, and care of equipment are some of the sub-headings. Boat drill for small boats closes the chapter.

The principles of sea-coast engineering, including hydrographic surveying, are given in Chapter X. Cordage, gins, shears, etc., the hydraulic jack and the magazine rifle occupy the two following chapters. The final chapter is called "Points for Coast Artillerists." It comprises fifty pages of suggestions on miscellaneous subjects, for example, commands for battle and fire command drill, for the searchlight and the communication officer, hints for the battery commander as to what is to be checked and particularly noted in his battery and stations; a synopsis of report of a calibration board; duties of emplacement and range officers and those detailed on the tug; shore-tug signals; duties of observers, gun-pointers and range-setters; camp sanitation.

The book is well indexed and profusely illustrated. Every instrument, gun, carriage and emplacement described, is shown in detail by one or more excellent cuts. In each, the names of the different parts are shown by clearly printed labels, making the comprehension of the picture easy, even to one unacquainted with its subject. The authors were very fortunate in having expert assistance in this most important part of their work.

Captain Hines and Major Ward have accomplished a signal service for both the regular and the reserve, coast artillery. To the latter it should be a matter of sincere congratulation that one of their number should be one of the authors of such a work. We have no hesitation in recommending it to anyone who is interested in the science of modern coast artillery, be he officer, or enlisted man, regular, or reserve.

Field Fortification. Notes on the Text Books. By Lieut.-General H. D. Hutchinson, C. S. I. Corrected to date by Colonel A. C. MacDonnel, late R. E. London: Gale & Polden, Ltd. 252 pp. XXXIV Plates. Price, 4 shillings, net.

That this well known publication continues to enjoy the public favor is amply evidenced by its having reached the sixth edition. As stated in the title page, the work is "especially designed and arranged for the use of officers preparing for Promotion Examinations," giving the book somewhat the character of a "Pony" on Field Fortification. This special object of the book is kept steadily in view in the treatment of the various subjects treated, particular emphasis being given in all cases to the essential principles involved and to the illustration of these principles by practical examples. But while the book disclaims being a text book, it falls short of being so only in the omission of certain technical details.

Chapter I is devoted to a general discussion of the arms and projectiles now in use with particular relation to their effect upon earth works. It is noted that the author uses the term "common shell" to include all shells containing a bursting charge, irrespective of its character.

Chapter II is devoted to a discussion of the underlying principles governing hasty intrenchments. Special emphasis is given, and very properly, too, to the relatively greater importance of a clear field of fire than to cover, a point, which, although admitted, is not infrequently violated in practice.

Chapter III treats of the details of fire trenches, including loop holes, overhead cover, cover trenches, etc., and presents the usual forms encountered in the latest text books.

Chapter IV treats of the ordinary and well known types of revetments.

Chapter V is devoted to a consideration of the execution of earth works and is especially valuable for its treatment of tasks and methods.

Chapter VI deals with clearing the foreground and gives good advice regarding removal of woods and orchards, it being pointed out that these may often afford less cover when standing than when cut down.

Chapter VII treats of the defense and utilization of accidental features of the terrain, and Chapter VIII of stockades and blockhouses.

Chapter X deals with the defense of villages, houses and woods and gives a number of very useful hints.

Chapter XI is devoted to a brief enunciation of redoubts. It is not surprising to learn that the author attaches little importance to the employment of closed works in a general defensive line, this view of the case being in accord with the latest thoughts on the subject.

Chapter XII is given over to the application of Field Fortification to Tactical Schemes, the subject being illustrated by an excellent example.

Chapter XIII is devoted to the subject of military bridges with brief references to the main features of the several types shown in the usual text books.

Chapter XIV treats in a brief manner the use of hasty demolitions and the principles involved.

Chapter XV deals with camping arrangements pointing out the principal features bearing upon the comfort, convenience and health of troops.

The work closes with a list of examination questions drawn from the several chapters of the book which must be of undoubted benefit to officers preparing for examinations.

The plates are in general clear and excellent and the numerous examples at the ends of chapters makes the treatment of the subject an exceedingly practical one. In fact, the general plan of enunciating principles and then following these up by examples is a most excellent method for teaching any subject, especially one pertaining to the military art, as has been conclusively shown by the results attained in the Army Service Schools of the United States.

While General Hutchinson's work, as revised by Colonel MacDonnell is peculiarly adapted to the needs of officers of the line it is valuable also to the military engineer, by keeping prominently before his mind the guiding and essential principles of the art of Field Fortification.

The Sword and How to Use It. By Lieut. J. Betts, Master at Arms, Aldershot. London: Gale & Polden, Ltd. 4¼ x 7. 73 pp. 17 il. Price, 50 cents.

The book, "The Sword and How to Use It," by Lieutenant J. Betts, Master at Arms, Army Gymnastic Staff, Aldershot, Champion Swordsman, Army and Navy, 1906-1907, though profusely illustrated by photo-engravings and arranged in progressive lessons for graduated instruction, can hardly be accepted as good by the exponents of any of the recognized schools of the art of self-defence.

There are two distinct schools in Europe which rightfully lay claim to the title "classical," and perhaps a third, the Austrian, which is in reality an offspring of the Italian though possessing sufficiently distinct features to be classed as one of three; namely, French, Italian, and Austrian. Undoubtedly

the Italian school is the best of the three in saber fencing. Though all of them differ in their methods and precepts, still certain cardinal principles are found in all and many of these are violated in the style of sword play proposed and taught by Lieutenant Betts in the above mentioned book.

The chief points on which followers of the classical schools of fencing must disagree with Lieutenant Betts will be pointed out in brief.

1st. The grip which he styles and pictures as incorrect is exactly that advocated by the French school, as it is necessary to their style of play. The other which he calls correct, is very similar to that of the Italian school which uses a very different style of play.

2nd. The position "on guard" with the arm fully extended is quite at variance with the teaching and practice of any classical school. In such a position one cannot parry and be in readiness to make the return or "riposte." Feints lose much of their purpose, namely, to make one's opponent uncover by parrying the feint, which must, to be effective, look or "feel" real. It is the quick extension of the flexed arm that puts life into the feint and forces the energetic parry in reply, thus leaving an opening.

3rd. The lunge is both constrained and dangerous, giving no chance to parry and return from the lunge, and to be ever ready to do this is the essence and criterion of good swordsmanship.

4th. The parries, also, on account of the straight arm, do not "cover" the target (one's own body) when threatened or really attacked so effectively as is possible with a flexed arm; and the return after the parry cannot be either as quick or as sure. The inconsistency of going on guard with the arm fully extended, a constrained attitude from which one cannot go to another without first relaxing or bending the arm, is shown by the fact that the swordsman who follows this teaching must circle as far back as the body to make a cut, thereby uncovering himself to an attack to an enterprising opponent.

5th. He has combined the circular cuts of the French school with the straight arm play of the Italian, and it seems to us, to the worst advantage possible. With the straight arm all cuts should be made with the wrist, while he advocates immobility of the wrist. With the circular cuts the hand must always be in front of the body, otherwise at the moment of attack one's opponent has an opening just at the time when he should be *entirely* engaged in defending himself if the attack is to land successfully. Every attack must be parried before the contestant supporting the attack has the right to riposte, but once the arm is bent the contestant supporting the attack *has* the right to attack in his turn, without parry, for the attack against him at that moment ceases. To the properly trained eye and hand no better chance for a *nice* point could be offered; the attack "on time."

To the followers of the classical schools of fencing this style of sword play appears to lack that fine appreciation of time and coordination of eye and hand which they inculcate. It seems to rely more upon luck or bull dog aggressiveness, to "bluff out" or break down the defence of an opponent instead of to deceive him by skill of brain or blade, and in so far we believe it is not good.

His remarks on managing competitions are good, but there is nothing new to be found therein, nor in his method of scoring. As a stimulant to sword play such a book may perhaps have a place, but we doubt its usefulness. Fencing cannot be taught *by* books nor learned *from* books. The personal contact of pupil and master, the ever present spur of emulation, the sense of time, the feel of the blade, the life of point or edge, no book can ever describe, for they

are appreciated through the sense of touch, the contact of blades and of personalities. All these can be learned only in the *salle d'armes*, in the presence of a master.

Taschenbuch der Kriegsflotten.—11th year 1910. Compiled by B. Weyer, Kapitän-Leutnant a. D. 509 p., with index 524 p. $6\frac{3}{4} \times 4\frac{1}{2}$. Very numerous cuts, sketches, silhouettes, and plans of ships. One appendix, Air-war-ships. Munich: J. F. Lehmann. Price, M4.50 (bound).

This very useful handbook is increased in size and scope by the addition of an appendix on Air-ships. This appendix concerns itself only with airship-ballons, aeroplanes are not touched upon. Cuts of the German, English, French, Italian and Russian airships are given with a table of airships of the same powers.

There is a vast mass of data in this handbook and usually it can be relied upon implicitly. There are five divisions of the work treating of the warships of all nations, general information relating to the navies of the powers, marine artillery, miscellaneous data, tables of personnel and conversion tables of all sorts of units. Excepting its lack of information concerning recent German construction, it is a most useful work.

The Shot-firer's Guide. A Practical Manual on Blasting and the Prevention of Blasting Accidents. By Wm. Maurice. New York: D. Van Nostrand Co. $5\frac{1}{2} \times 8\frac{1}{2}$. 203 pp. 78 ll. Price, \$1.50 net.

The author in his introduction to the manual, enters into the question of loss of life in England through carelessness and ignorance in regard to the use of high explosives. His book represents an effort to present simply and briefly, to the practical man who has but a limited education, a systematic array of questions and answers which will enable him to avoid the danger attaching to men using high explosives or at least reduce this danger to a minimum. In this effort he is successful in bringing the work down to that clearness and simplicity required in such cases.

On the average, in England, one man every day is injured and one every week dies from injuries received in blasting, most of which would be avoided if proper precautions were observed by the operators or by those responsible for the antecedents to the accident.

It is the purpose of the book to instruct workmen in the requirements of safety and if read carefully and applied intelligently, material improvement over the present conditions should result. In order that workmen may secure a copy of the manual the price is placed as low as possible. A summary of the book will show how well the same is adapted to its purpose.

The first chapter deals with the nature of explosives, nature and cause of explosion, and the practical difference between explosion and detonation. The information is presented by asking questions printed in bold-face type, followed by the answer more or less extended, depending on the importance of the subject. In reading the answer one unconsciously absorbs the desired information.

Explosives are considered under five heads, or classes, depending upon their chemical constitution. 1. Those formed from nitro-glycerine; 2. From ammonium-nitrate; 3. Formed by mixing 1 and 2; 4. Non-detonating mechanical mixtures, and 5. Gunpowder.

The English Regulations governing these are applied and explained and a list of "permitted" explosives given. Two chapters are taken up with detonators and fuzes, means of exploding them and testing the circuits. The text

is clear, but the illustrations are the best part of the book, since they are so numerous and clear that a glance only is necessary to understand the device in question. Firing in mixed gases in its relation to the above is considered.

Chapter III is devoted to practical applications. It covers the field of avoidable accidents and how to avoid them. Chapter IV takes up the question of accidents resulting from ignition of inflammable gases, and Chapter V the laws and regulations applying to storage and use of explosives. This chapter shows how well the subject is governed and regulated in England.

Appendices complete the book, consisting of a summary of the main conclusions relating to shot-firing, testing for gas, coal dust experiments, and examination questions pertaining to the contents of the manual.

It is impossible to do the practical side of the book justice in a short review. To a man engaging in blasting, or to one wishing to learn this business the manual should be invaluable. Adherence to its teachings and principles would save many lives in our own country where there is little or no supervision by competent authority.

For military men the book should have a great value. We regret that we have not more officers and men skilled in the subject discussed, particularly in the coast artillery corps, which at any time may be called upon to operate mines, destroy obstacles or construct fortifications. At least ten men in each company should be conversant with the contents of this book and able to do the practical work described therein. High explosives are adapted in a most emphatic way to the accomplishment of great quantities of work in a short time and if thoroughly understood and applied would aid the troops in erecting parapets, securing cover and clearing the field of fire. In the hands of a skilled party of but a few men, explosives may be used for opening a trench which would afford ample cover from the moment of exploding charges, judiciously selected and placed in line. The resulting trench could be occupied at once and developed at will by the men who would be thoroughly protected while working. It is believed that a regiment could be put under cover within a few minutes after the position had been selected and without exposing more than a small party which would not attract attention. Reading and studying the book will suggest other applications to the military man and we commend it to all who may be interested in the subject.

Lectures on the Strategy of the France-German War (1870) Up to the Battle of Sedan. By Brevet-Major W. D. Bird, D. S. O. London: Hugh Rees, Ltd., 119 Pall Mall, S. W. 5 $\frac{3}{4}$ x 8 $\frac{3}{4}$. Cloth. Il. Price, 6 shillings net.

The author originally presented the matter contained in this book in the form of a course of lectures at the Staff College at Quetta, Baluchistan. The first four chapters described the French operations, with the information concerning the enemy which they had and upon which they based their actions. The next three chapters similarly tell of the movements of the German forces. A good feature of the work is its small maps, two on a page, the upper showing the supposed position of the enemy, the lower their actual position on a particular day. These maps are given for frequent dates, so that the general on-ward movement can be followed continuously.

Twelve problems suggested by the campaign follow the text. Seven tables are in pocket at end, showing the organizations of the two armies and the movements from day to day, of each of the larger units, up to August 31st. In pocket in front are two excellent sketch maps, showing, one the rail lines used

by the Germans for the transportation of their forces, the other the roads over which the armies moved in the theatre of operations.

The book is well written, the comments are good and anyone studying this campaign would be well repaid for consulting its pages. In paper, typography and binding the book is very good.

Azimuth. By George L. Hosmer, Assistant Professor of Civil Engineering, Mass. Inst. Tech. New York: John Wiley & Sons. $4\frac{1}{2} \times 7\frac{1}{2}$. 73 pp. 6 il. 1909. Price \$1.00.

A good book for every Coast Artilleryman to have. The author has endeavored to so present his subject that a person who is unfamiliar with astronomy will be able to apply his methods and obtain satisfactory results without mastering the theory underlying the method used. The rules and tables have been put in a compact form so that the book can be carried into the field and the results worked up at once if necessary. Many approximations are made and many refinements omitted, which, considered in its application to our use would cause no serious errors, as our instruments are ordinarily no more precise than the ordinary Engineer's transit, and our observers are not professionals.

The author describes the methods of finding the azimuth by observations on the altitudes of a star or of the sun, by observations on Polaris and either δ Cassiopeie or δ Draconis, and also by means of Polaris at culmination. For all of these methods, this book contains all of the necessary tables, etc., and no other need be consulted. For other methods, it is usually necessary to have at hand a copy of the Ephemeris or Nautical Almanac.

The methods by observed equal altitudes of a star or of the sun are also described. These methods are not ordinarily presented.

The above mentioned methods are intended to give results that will be sufficiently accurate for a check on the angles of an ordinary survey, but in them precision is sacrificed to convenience and rapidity of computation.

The author's method by observation on Polaris is intended to fill the requirements of a more precise method. In determining the hour angle of Polaris he uses the time star method, which would seem to be not as good for our purposes as to compute it from the Ephemeris.

The Theory of the Recoil of Guns with Recoil Cylinders. By Professor F. Rausenberger. Translated by Alfred Slater. Crosby Lockwood and Son. 7 Stationers Court Hall, Ludgate Hill, London. 5x9. Price \$4.50 net.

The translator remarks that "owing to the extreme secrecy with which the science of gunners is regarded in this country, (England) there is very little really important English literature dealing with guns and gun mountings available."

He has selected from an abundant continental literature on the subject, that which he considers the most exhaustive and complete treatise extant.

The forces acting on a gun mounting during and subsequent to discharge are mathematically analyzed. The constants required in the various equations have been given as determined by the best modern practice. The general types of recoil devices analyzed covers modern gun mounting designs.

This is a book, or rather a manual, for the gun carriage designer and constructor.

To the user of Artillery, if he masters this work, his gun mounting will be no longer mysterious to him.

Einheitsgeschosse (Universal Field Artillery Projectiles). By Major-General R. Wille. Berlin: R. Eisenschmidt, 70 A. Dorotheenstrasse. $6\frac{1}{2} \times 9\frac{1}{2}$. 83 pp. 43 il., 5 plates.

This is an interesting text in which the development of case shot, shrapnel and high explosive shell for field guns is discussed.

The diagrams and the descriptions of the various projectiles are clear, while their destructive effect is portrayed in a series of tables and plates. The author states that "the *granats-shrapnel* c/1909 made by Fried Krupp, is at the present time the best built and most effective of all known field artillery explosive projectiles."

The Field Gunner's Catechism. By Major A.T. Anderson, Royal Field Artillery. 2nd Edition. $4\frac{1}{4} \times 5\frac{1}{2}$. London: Gale and Polden, Ltd., 2 Amen Corner, Paternoster Row, E.C. Price, one shilling and six pence, net.

This booklet is intended to furnish the British Field Artillery soldier practical information as to his duties.

The literary form, that of questions and answers, is well adapted to the end in view.

The questions are sharp and to the point, and the definitions are clearly and plainly expressed. There is an entire absence of the literary chaff which some writers of similar books seem to think necessary to prevent "bolting," and equally so of that solidity, noticeable in some of our handbooks, which prevents digestion and assimilation.

The book abounds in handy, easily remembered and applied rules of gunnery.

It is to be noted that in the British service they still cling to the clumsy degrees and minutes angular divisions. In fact the entire "Drill" seems cumbersome, but this is not the fault of the author.

The descriptions of the gun and material apply to the British service but there are many parts that are of interest to the general reader.



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TO

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| A—2 Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
<i>Getreidemarkt 9,</i>
<i>Wien VI.</i> | <i>Monthly</i>
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| A—3 Streffeurs Militaerische Zeitschrift,
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<i>I. Graben, 13. Wien</i> | <i>Monthly</i>
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| A—4 Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereine.
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Falleres del Estado Mayor-Jeneral. Bimonthly
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